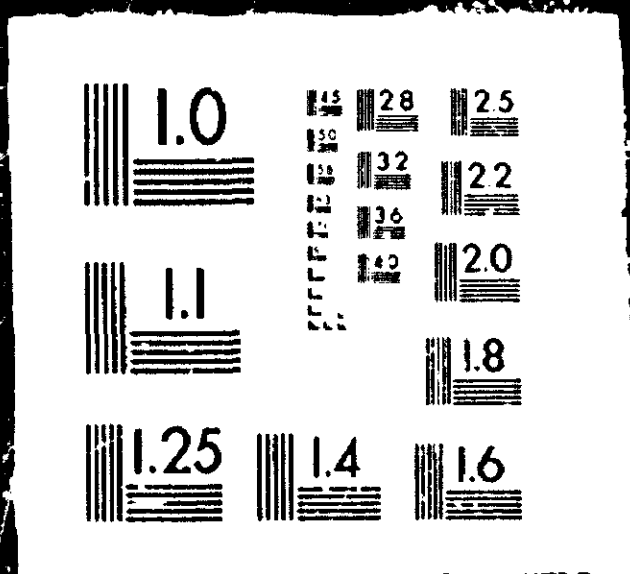


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Special Investigation Report: Eight Subway Train
Fires on New York City Transit Authority with
Evacuation of Passengers

(U.S.) National Transportation Safety Board
Washington, DC

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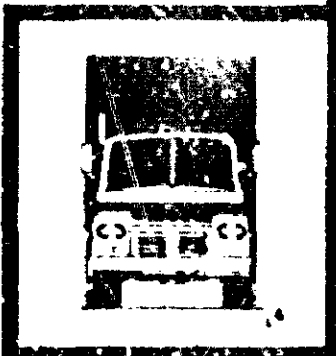
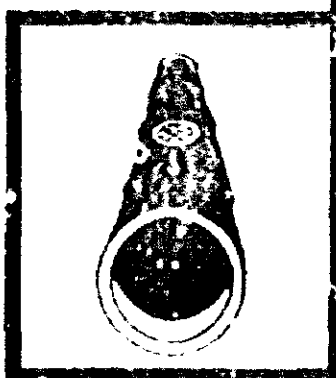
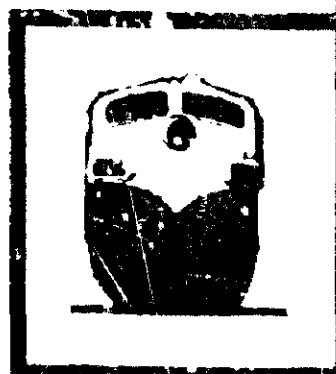
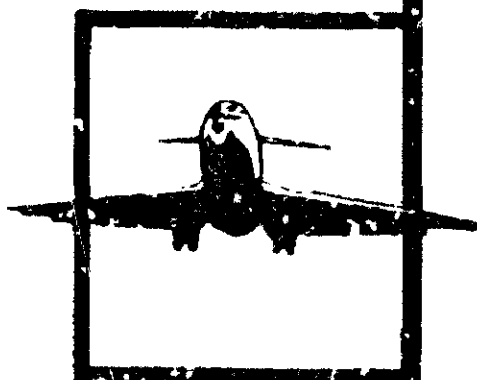
SPECIAL INVESTIGATION REPORT

**EIGHT SUBWAY TRAIN FIRES ON
NEW YORK CITY TRANSIT AUTHORITY
WITH EVACUATION OF PASSENGERS**

NTSB-SIR-81-5

UNITED STATES GOVERNMENT

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16. Abstract Since 1975, the National Transportation Safety Board has investigated more than 20 train accidents on rail rapid transit systems. These investigations revealed many safety problems which appeared to be industrywide in scope. Some of the problems were identified in more than one accident involving a single transit system. The incidence of recurring industrywide safety problems heightened the Safety Board's concern about the safety of these systems. Because of this concern, on July 28, 1980, the Safety Board convened the first National Public Hearing in Rail Rapid Transit Safety. During the hearing, which focused primarily on fire safety, the Safety Board heard testimony from 25 witnesses and subsequently presented its findings in its report, "Safety Effectiveness Evaluation of Rail Rapid Transit Safety" (Report No. NTSB-SEE-81-1, January 22, 1981). The evaluation identified serious fire safety problems and contained 31 recommendations for safety improvements. During a 13-month period beginning about 1 month before the Safety Board's public hearing, eight serious subway train fires involving passenger evacuation occurred on the New York City Transit Authority (NYCTA). As these accidents were investigated, certain similarities among them emerged and are described in this report. The eight accidents resulted in 53 injuries and property damage to subway cars in excess of \$500,000.			
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**NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594**

SPECIAL INVESTIGATION

Adopted: September 22, 1981

**EIGHT SUBWAY TRAIN FIRES
ON THE NEW YORK CITY TRANSIT AUTHORITY
WITH EVACUATION OF PASSENGERS**

INTRODUCTION

Since 1975, the National Transportation Safety Board has investigated more than 20 train accidents on rail rapid transit systems. These investigations revealed many safety problems which appeared to be industrywide in scope. Some of the problems were identified in more than one accident involving a single transit system.

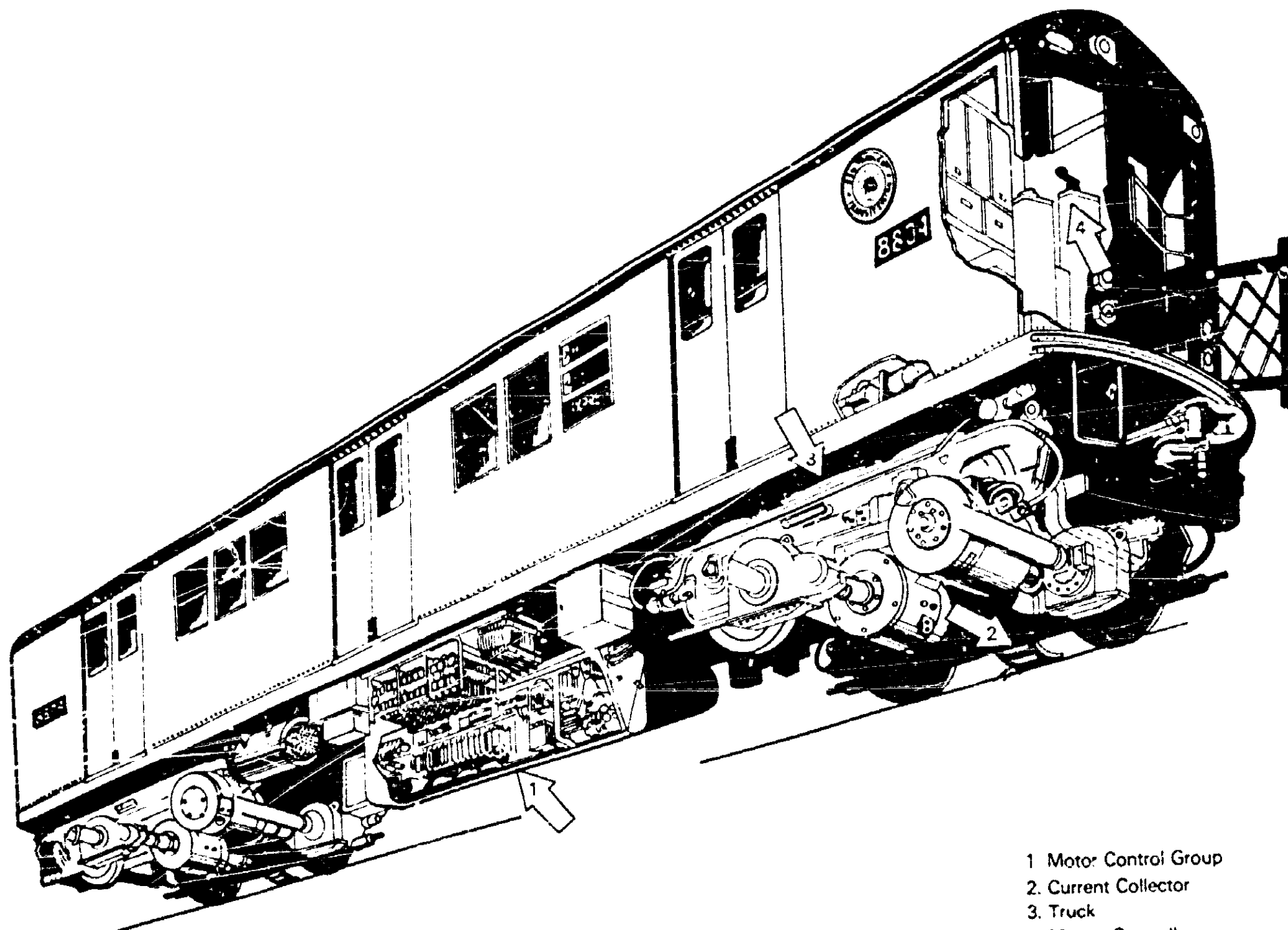
The incidence of recurring industrywide safety problems heightened the Safety Board's concern about the safety of these systems. Because of this concern, on July 26, 1980, the Safety Board convened the first National Public Hearing into Rail Rapid Transit Safety. During the hearing, which focused primarily on fire safety, the Safety Board heard testimony from 25 witnesses and subsequently presented its findings in its report, "Safety Effectiveness Evaluation of Rail Rapid Transit Safety" (Report No. NTSB-SEE-81-1, January 22, 1981). The evaluation identified serious fire safety problems and contained 31 recommendations for safety improvements.

During a 13-month period beginning about 1 month before the Safety Board's public hearing, eight serious subway train fires involving passenger evacuation occurred on the New York City Transit Authority (NYCTA). As these accidents were investigated, certain similarities among them emerged.

On June 25, 1980, NYCTA notified the Safety Board that an accident involving a train on fire had occurred in an NYCTA subway tunnel. An investigation conducted by the Safety Board's New York City Field Office identified certain electrical components of a subway car--the motor control group (see figure 1)--as the origin of the fire.

In December 1980, NYCTA notified the Safety Board of two accidents involving trains on fire which occurred on December 10 and 11, respectively. When preliminary investigation by the New York City Field Office revealed that the fires originated in car motor control groups, the Safety Board initiated a special investigation to examine the similarities in the three motor control group fires. The special investigation subsequently was expanded to include a fourth NYCTA subway train fire involving a motor control group which occurred on April 29, 1981, and came to the Safety Board's attention through news media reports.

On April 21, 1981, about 1 week before the fourth motor control group fire, NYCTA notified the Safety Board of a subway train fire which Board investigators later determined had originated in a different subway car electrical component, a current collector. (See figure 1.) Subsequently, the Board learned through news media reports of three similar NYCTA subway train current collector fires which occurred on May 6, May 15, and July 29, 1981.



Courtesy New York City Transit Authority

- 1 Motor Control Group
- 2 Current Collector
- 3 Truck
- 4 Master Controller

Figure 1.--New York City Transit Authority subway car.

These eight accidents spanning a 13-month period resulted in 53 injuries and property damage to subway cars in excess of \$500,000. In addition to the safety issues raised by the similarities among the fires within each series of four accidents, the eight subway train fires involved evacuation of passengers, the application of established emergency procedures, and related survival aspects which have been explored by the Safety Board in previous accident investigations, safety recommendations, public hearings, and safety effectiveness evaluations.

This special investigation was conducted to examine similar aspects of these eight accidents and the two accident subgroups, with the objective of identifying safety improvements needed to prevent the recurrence of accidents or reduce the potential severity of their consequences.

This special investigation is based, in part, on full field investigations of the first three accidents involving motor control group fires and the first accident involving current collector fires. These field investigations are identified by Safety Board file number at appendix A.

MOTOR CONTROL GROUP FIRES

The motor control group, located under the floor at the center of the rail rapid transit cars involved in these accidents, contains electrical control devices for car operation (see figure 2). In response to the activation of controls in the operating compartment of the car, the devices within the motor control group activate electrical circuits to control the power, braking, coasting, and reversing functions of the train. When a rail rapid transit train is assembled, the controller in the operating compartment of the lead car is selected as the 'master controller' to run the train, and the controllers in the other cars in the train are left in the off, or inoperative, position. The motor control group of each car relays power from car to car in series according to the functions selected by the master controller, but only the master controller selects the circuits that control the operation of the train.

Several types of motor control groups are used on NYCTA subway cars. One of two different types of motor control groups manufactured by two different firms--the General Electric Company and the Westinghouse Electric Company--has been used on all NYCTA cars from the R-12 car introduced into service in July 1948 to the R-40 car placed in service in January 1968. Different types of motor control groups are used on cars introduced after January 1968.

While the General Electric and Westinghouse motor control groups are similar, they use different methods to select the circuits for the various train functions. The motor control group manufactured by the General Electric Company selects the circuits electrically; the one manufactured by the Westinghouse Electric Company uses an air-operated cam to select circuits and thus requires air lines in the motor control group to supply air to the cam.

Accidents Investigated

NYCTA is divided into two operating divisions, the IRT and the BMT-IND. ^{1/} Three of the four accidents investigated involved motor control group fires which occurred on cars of the IRT Division; the fourth occurred on a BMT-IND Division car. These accidents are described below.

^{1/} Originally these were independent rapid transit systems known as the Interborough Rapid Transit (IRT) and the Brooklyn Manhattan Transfer Independent System (BMT-IND).

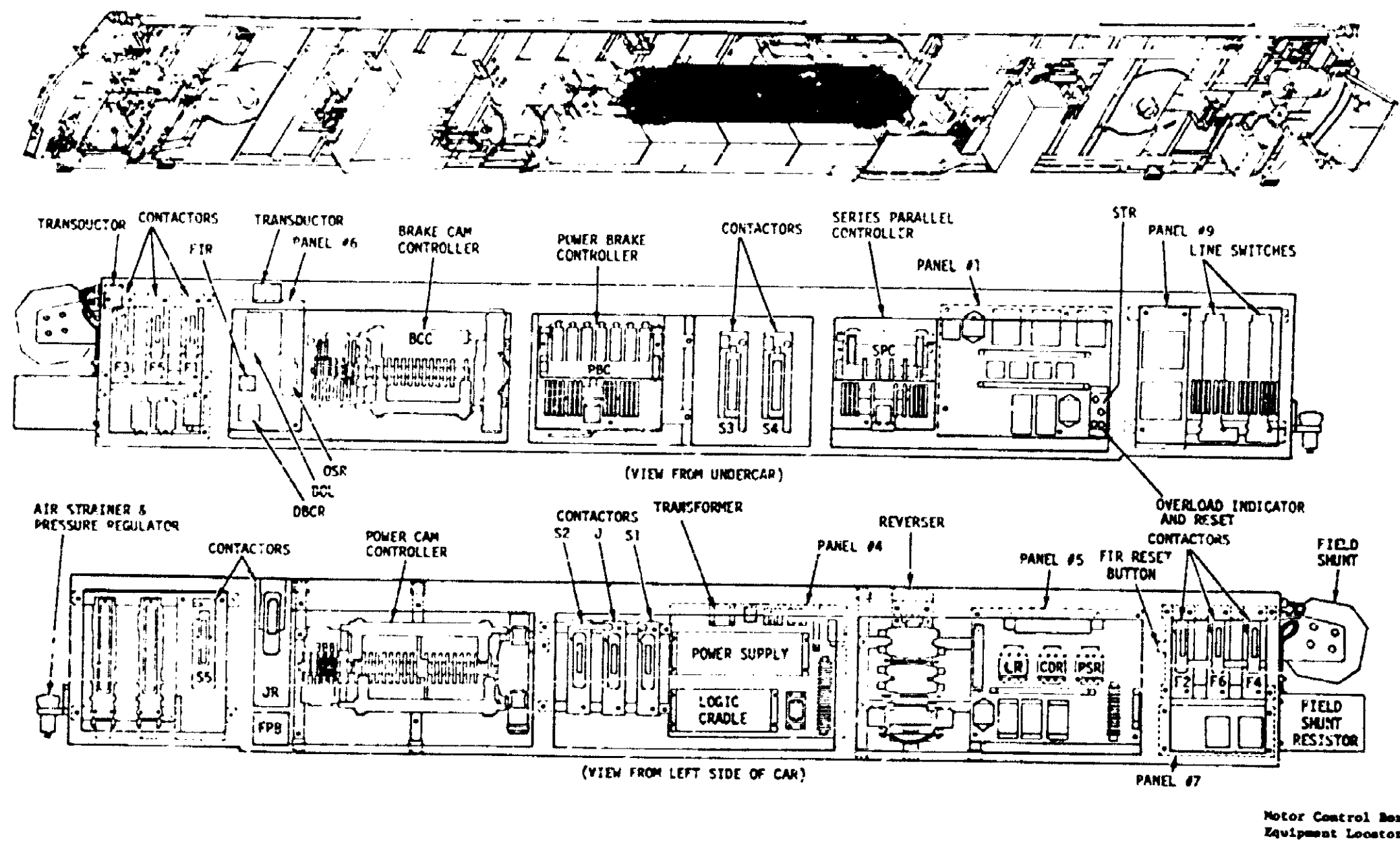


Figure 2.--Diagram of a motor control group.

Investigation A

On June 25, 1980, at 5:12 p.m., NYCTA southbound subway train No. 5 with 10 cars was departing the 86th Street Station when the conductor reported to the motorman that an explosion had occurred and smoke was coming from the sixth car in the train. The motorman immediately stopped the train and went back to investigate the problem.

All 10 cars of the train were in the tunnel approximately 275 feet south of the 86th Street Station. Because heavy smoke was coming from under the sixth car, the conductor moved the passengers from the sixth car into the forward cars but was unable to reach the passengers in the rear cars because of the heavy smoke. The motorman returned to the operating cab in the first car to attempt to start the train to proceed to the next station, but the train would not respond. At 5:14 p.m., 2 minutes after the fire began, a following train discharged passengers at the 86th Street Station and then proceeded to the rear of the disabled train to function as a bridge between the passengers in the last four cars and the station platform. At 5:22 p.m., a trainmaster arrived on site, and the passengers began to pass through the bridge train to the 86th Street Station platform. By 5:33 p.m., 21 minutes after the fire began, the passengers had been removed from the cars and were at the station. The trainmaster then proceeded forward, covering his mouth and nose with a handkerchief because of the severe heat and smoke condition, and located the motorman who was attempting to cut away ^{2/} the four head cars. By working together, the motorman and trainmaster were able to cut away the cars and the motorman then proceeded to the 59th Street Station. All passengers were discharged by 5:40 p.m., 28 minutes after the fire began.

At 5:46 p.m., 34 minutes after the fire began, the fire department arrived and requested that the burning car be moved to the 86th Street Station to extinguish the fire. The trainmaster attempted to move the remaining five cars back to the 86th Street Station but could not get the cars to respond. At 6:10 p.m., the third rail power was removed and the fire department began to move into the tunnel with hoses. At 6:43 p.m., 1 hour and 31 minutes after the fire began, the fire was extinguished and the fire department began to remove their hoses. At 7:09 p.m., third rail power was restored and at 7:34 p.m., 2 hours and 22 minutes after the fire began, normal train service resumed.

Five passengers, the conductor, and four police officers were taken to the hospital and treated for smoke inhalation; two of the police officers were hospitalized.

The fire, which originated in the General Electric motor control group, had destroyed the group switch box, burned away metal conduits and power cables, and burned through a 2-foot by 8-foot area of the floor. The interior of the car was coated with a heavy layer of soot. Damage to this car was estimated to be \$75,000.

Investigation B

On December 10, 1980, a 10-car northbound "F" train was standing in the Lexington Avenue Station at 8:50 p.m. when the motorman reported to the command center that smoke was issuing from under the eighth car. He discharged the passengers and started the train to move it to a layup track; ^{3/} however, while en route an undesired

^{2/} Subway cars are designed to be 'cut away,' or uncoupled, by any of three methods: by pushing a button in the operating compartment of the car involved; by pushing a button located outside, at the end of the car; or by operating a mechanical lever on the coupler.

^{3/} A track used to store trains during nonrush hours.

application of the train brakes occurred ^{4/} and the train stopped in the tunnel 100 feet south of the Queens Plaza station. The motorman was unable to regain air pressure to release the brakes and as a result he was unable to move the train.

At 9:08 p.m., 18 minutes after the fire began, a train passing on an adjacent track reported a very heavy smoke condition in the tunnel. A road car inspector was sent from the Queens Plaza Station to investigate and arrived at the train at 9:14 p.m., 24 minutes after the fire began. He and the motorman then proceeded to the eighth car. Because of the heavy smoke condition, the motorman requested that the third rail power be removed; at 9:18 p.m., power was shut off from the track. At 9:28 p.m., 38 minutes after the fire began, the road car inspector requested that the fire department respond to the fire and at 9:32 p.m., 42 minutes after the fire began, the fire department was called. The road car inspector also requested that a train pass through the fire area on an adjacent track to clear smoke from the tunnel. At 9:50 p.m., a train with no passengers on board passed through the area and the motorman of this train reported that the smoke in the tunnel reduced visibility to near zero.

At 9:49 p.m., 59 minutes after the fire began, the fire department arrived and began checking for exits through which they could bring hoses from the street level. The power was removed from the third rail on the adjacent tracks at 10:16 p.m. The fire department ran water hoses from the 23d Street Ely Station and reached the car at 10:39 p.m., 1 hour and 49 minutes after the fire began. At 11:27 p.m., 2 hours and 37 minutes after the fire began, the fire was extinguished and the fire department began to leave the area. The fire department gave clearance to restore electrical power to the third rail at midnight, 3 hours and 10 minutes after the fire began. The fire destroyed the motor control group, all main line cables and control wires, and melted the wire conduits near the motor control group. The intense fire, which originated in the Westinghouse motor control group, also distorted the underframe structure and the center exterior side sheet of the car, completely consumed the interior switch panel of the group switch box, burned off main line cables and control wires, including the main airbrake line (see figure 3) and the air lines to the motor control group cam, and melted the wire conduits passing over and nearby the group switch box. After the fire burned through the floor in the center of the car (see figure 4), it destroyed the center section of the fiberglass passenger seats (see figure 5), and left a heavy coating of soot on the ceiling (see figure 6).

Investigation C

At 5:35 p.m. on December 11, 1980, Train No. 6 with 10 cars was departing the Brook Avenue Station when the train brakes went into emergency and smoke began coming from under the eighth car. The train stopped with the two rear cars in the station and the head eight cars in the tunnel. While the motorman attempted to recharge the train brakes, the conductor discharged the passengers from the two rear cars onto the Brook Avenue Station platform; he was unable, however, to reach the passengers ahead of the eighth car because of the fire and smoke. The motorman was unsuccessful in his attempt to release the train brakes.

At 6:06 p.m., 31 minutes after the fire began, a motorman instructor arrived at the train. He then went to the second car in the train and set it up as the controlling unit and unsuccessfully attempted to release the train brakes from that position. At 6:12 p.m.,

^{4/} An undesired application of the train brakes occurs when the train brakes apply without being initiated by the motorman. Loss of air from the train airbrake line when the line is ruptured will cause an undesired application of the train brakes.



Figure 3.—Ruptured train brake air line.

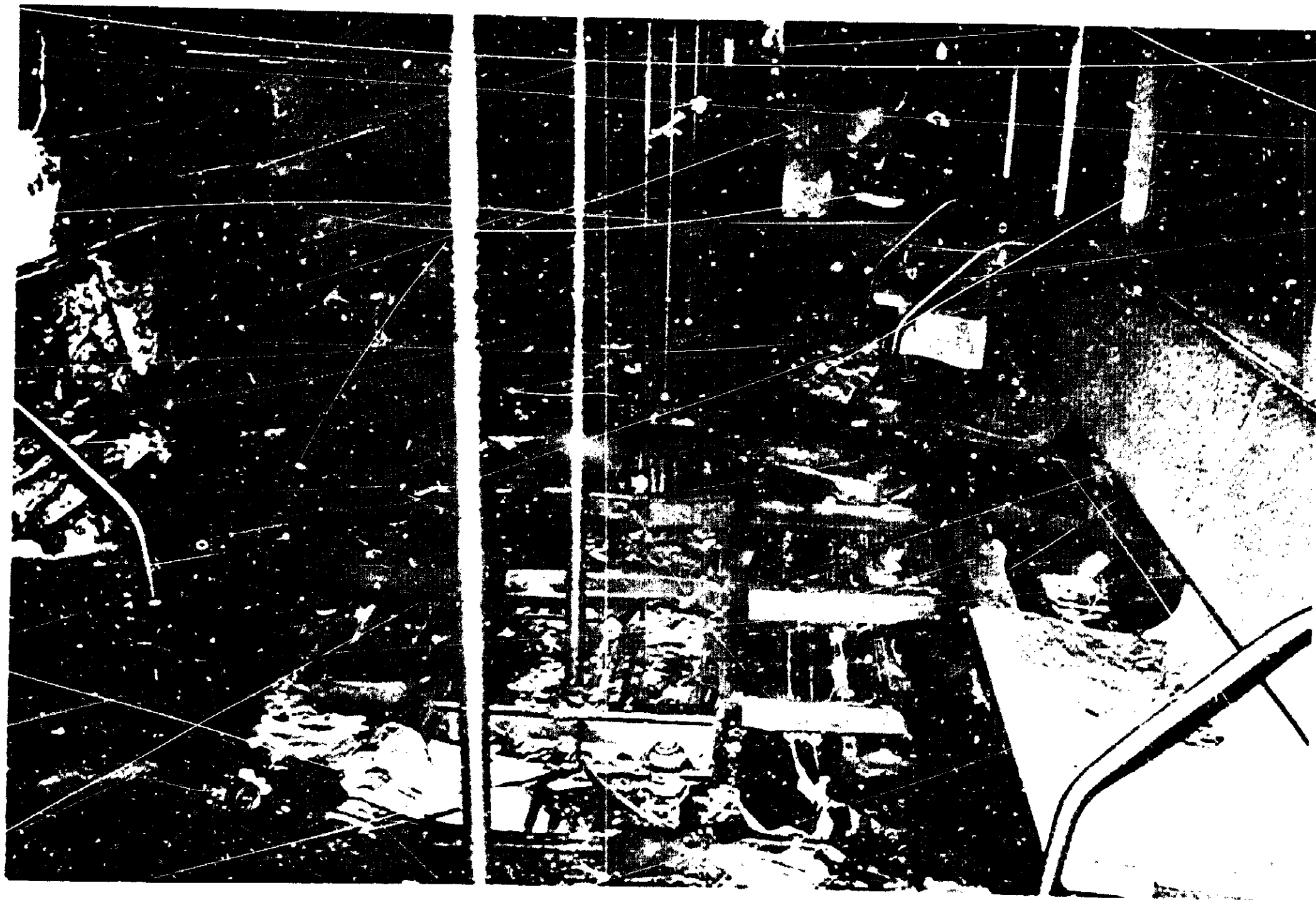


Figure 4.—Floor burned through in a motor control group fire.



Figure 5.—Center section seats burned out in a motor control group fire.



Figure 6.—Heavy accumulation of soot resulting from a motor control group fire.

37 minutes after the fire began, the motorman instructor started to evacuate the passengers in the seven cars ahead of the fire onto the tunnel catwalk and through an emergency exit to the street. At 6:31 p.m., 56 minutes after the fire began, the motorman instructor reported that all passengers had been evacuated to the street. One passenger was taken to the hospital for treatment of smoke inhalation.

The fire department arrived at the scene at 6:08 p.m., 33 minutes after the fire began, and requested that power to the third rail be turned off; at 6:13 p.m. the power was removed. The fire department assisted in the evacuation and extinguished the fire. After the fire was extinguished, smoke began subsiding at 7:33 p.m. and the fire department then departed. Power was restored to the third rail at 8:45 p.m., 3 hours and 10 minutes after the fire began.

The fire, which originated in the Westinghouse motor control group, destroyed the motor control group, all main line cables and control wires, and melted the wire conduits near the motor control group. Pneumatic and main airbrake system lines were heated and ruptured, thereby feeding air to the fire area. The intense fire distorted the underframe structure of the car and burned through the plymetal floor (plywood floor with aluminum sheeting on the bottom and vinyl asbestos tile on the car interior floor). Damage was estimated to be \$60,000.

Investigation D

At 10:53 p.m. on April 29, 1981, a southbound nine-car train was entering the 96th Street Station when the motorman reported to the command center that smoke was coming from under the second car in the train. The passengers were discharged onto the station platform. At 11:10 p.m., 17 minutes after the fire began, a trainmaster at the scene reported that the fire had become more intense and that smoke was heavy in the area. Power to the third rail on the track was cut off. At 11:23 p.m., 30 minutes after the fire began, the motorman of another train in the area reported that smoke was so dense that he was unable to see signals. He discharged the passengers from his train onto the station platform at 79th Street. At 11:27 p.m., the power was removed from track No. 3.

At 11:29 p.m., 36 minutes after the fire began, the fire department arrived and requested that the power also be shut off from track No. 1; at 11:34 p.m. the power was cut. At 12:14 a.m., 1 hour and 21 minutes after the fire began, the fire was extinguished and the fire department subsequently departed. Power was restored to track No. 1 and track No. 3 at 12:21 a.m. and 12:25 a.m., respectively. Smoke was reported as dense at both times. At 12:37 a.m., the power was restored to track No. 2 and the motorman instructor, who was operating from the third car, moved the train out of the area at 12:49 a.m., 1 hour and 56 minutes after the fire began. Several trains without passengers were sent through the area to clear the smoke out of the tunnel. At 1:11 a.m., 2 hours and 18 minutes after the fire began, the smoke was light and normal service was resumed. The motorman and conductor were taken to the hospital for treatment of smoke inhalation.

The intense fire destroyed the Westinghouse motor control group and the main line cables and control wires, and melted the wire conduits near the control group. The air line to the motor control group was ruptured, thereby feeding air to the fire. The underframe structure and floor of the car were damaged.

Inspection and Maintenance

NYCTA has an established schedule for inspections of subway car equipment, including two types of major inspections ("B" and "C") involving the motor control groups

and 23 other equipment items or groups. Each car is required to be inspected in one of the car barns every 10,000 miles of operation. ^{5/} A "B" inspection is performed after the first and second 10,000 miles and a "C" inspection is performed after the third 10,000 miles. The cycle then resumes with a "B" inspection.

At each "B" inspection, the box containing the motor control group is opened and the various parts are inspected, cleaned, and lubricated. Worn or burnt parts are replaced as necessary. The "C" inspection involves the same procedures as the "B" inspection, with added requirements for testing, adjusting, and repairing certain components. Before the car is released into service, a quality assurance inspector checks the work and records his inspection on a form. The inspection form includes the inspector's certification that "Items opposite my signature were inspected by me and left in good condition for service." The 10,000-mile interval between car inspections in the "B" and "C" cycles was established by NYCTA in October 1978. Before October 1978, the specified interval between these car inspections was 7,500 miles. ^{6/}

In June 1980, NYCTA implemented a Standard Inspection Procedure prescribing uniform procedures in all car barns for motor control group inspections.

The Safety Board's investigation of shop inspection and maintenance records revealed the following information with respect to the accidents investigated.

- o The car involved in the accident on June 25, 1980 (accident A) received a "C" inspection on May 30, 25 days before the accident; while the car was in the shop for other repairs the day before the accident, the line breaker switch cover was opened. The car was placed back into service the day of the accident. Postaccident examination of the car revealed that the line breaker switch cover was missing; an exhaustive search of the accident site failed to locate this cover.
- o The car involved in the accident on December 10, 1980 (accident B) received a "C" inspection on December 1, 9 days before the accident.
- o The car involved in the accident on December 11, 1980 (accident C) received a "B" inspection on November 24, 17 days before the accident. Ten days later, on December 4, an inspector ordered the car off the road for correction of motor control group problems; however, the car was left in service without repairs until the accident occurred 7 days later.
- o The car involved in the accident on April 29, 1981 (accident D) was in the shop for replacement of a motor control group component on April 28, the day before the accident. The repair was certified as having been completed at the car barn. However, a senior maintenance superintendent at the main repair shop told investigators that in order for the component to have been replaced at the car barn, the car barn would have had to have requested a new component and two car repairmen from the main shop; there was no record that the car barn had requested the component or the repairmen, and the maintenance superintendent stated that they had not been sent.

^{5/} Depending upon the types of service in which the various types of cars are used, it takes about 3 to 7 months to accumulate 10,000 miles on a car.

^{6/} National Transportation Safety Board Railroad Accident Report, "Derailment of New York City Transit Authority Subway Train, New York, New York, December 12, 1978" (NTSB-RAR-79-8, August 2, 1979).

During the investigation of the third motor control group fire (accident C), Safety Board investigators were informed that by March 1981 NYCTA would be taking the following steps to prevent these types of fires:

- o Programs were being instituted in IRT car barns to relocate an electric resistor from inside the control box to the outside undercar frame for all Westinghouse motor control groups.
- o Boots were being placed on the group box cover coil springs to prevent chafing of high voltage wires.
- o A training program was initiated in IRT car barns using NYCTA Training Center personnel to train and certify the proficiency of car inspectors responsible for performing motor control group inspections.
- o Surveillance of motor control group inspection and repair was increased, and reinstruction or disciplinary action would be taken as necessary.
- o Supervisory training was being given to shop foremen assigned to motor control group inspection.

A maintenance superintendent told Safety Board investigators that his car inspectors and repairmen generally have about 2 years experience. They are given no formal training by NYCTA; their only training is on the job.

Data on Motor Control Group Fire Experience

Officers of the NYCTA Car Maintenance Department told Safety Board investigators that motor control group fires have been a major problem and occur frequently. A search of the Department's automated data system, which records all equipment failures in a case history for each car, indicated that of the 2,657 electrical fires that occurred on IRT Division cars during 1979 and 1980, 2,603 (98 percent) involved the motor control group. However, the data system is not programmed to distinguish major fires from minor fires.

To determine the incidence of major fires involving the motor control groups, Safety Board investigators manually searched shop records and identified 66 motor control group 'heavy burnups' ^{7/} that occurred on IRT Division cars during 1979 and 1980. (See appendix B.) The total number of cars in the car fleet remained constant during these 2 years while the number of motor control group heavy burnups increased, from 30 in 1979 to 36 in 1980. Data were not available for the first half of 1978; however, a search of shop records for IRT Division cars indicated that 10 heavy burnups occurred during the last half of 1978 compared to 19 for the last half of 1979 and 25 for the same period in 1980.

A preliminary check of records of NYCTA's other division, the BMT-IND, indicated that because of differences in recordkeeping between the two divisions a manual search of the records of that division would require an effort so extensive that it would be beyond the scope of this investigation. Consequently, motor control group fire and heavy burnup data were not compiled for the BMT-IND Division.

^{7/} For the purposes of this investigation, the term 'heavy burnups' is used to identify major motor control group fires based upon the extent of damage to the car and equipment using the following criteria: destruction of the motor control group with both floor damage and structural damage to the car.

Of the 66 heavy burnups of IRT Division cars in 1979 and 1980, 51 involved motor control groups manufactured by Westinghouse and 15 involved the motor control group manufactured by General Electric. In the entire NYCTA subway car fleet, the numbers of cars having each type of motor control group are nearly equal; as of September 8, 1981, 3,241 cars were equipped with the Westinghouse unit and 3,190 cars were equipped with the General Electric unit.

CURRENT COLLECTOR FIRES

All of the cars involved in the four current collector fires investigated were R-46 cars purchased by NYCTA at an average cost of \$275,000 each using 80 percent Federal funds and 20 percent NYCTA funds. R-46 cars are 75 feet long, have a capacity of 300 passengers, and are designed to operate in pairs. Each pair of cars is semipermanently coupled, with operating compartments located at opposite ends of the car pair. Each R-46 car has four doors on each side for exiting at station platforms and an emergency exit at either end of the car.

R-46 cars are equipped with four current collectors--two on each side--which are mounted to the truck ^{8/} side frame. The current collectors transfer the 600-volt electrical power from the wayside third rail through cables on the car to the various electrical systems of the car. The current collector's major components include a collector paddle, paddle mount, shunt assembly, plastic mounting bracket, fuse, and fuse mounting bracket. (See figure 7.)

The collector paddle extends from the side of the car and rides on top of the third rail. When the paddle is on an energized third rail, it transfers electrical energy through the shunt assembly to the car's electrical systems. The circuit is fused to protect the car's electrical components against a surge of power exceeding 600 volts.

Accidents Investigated

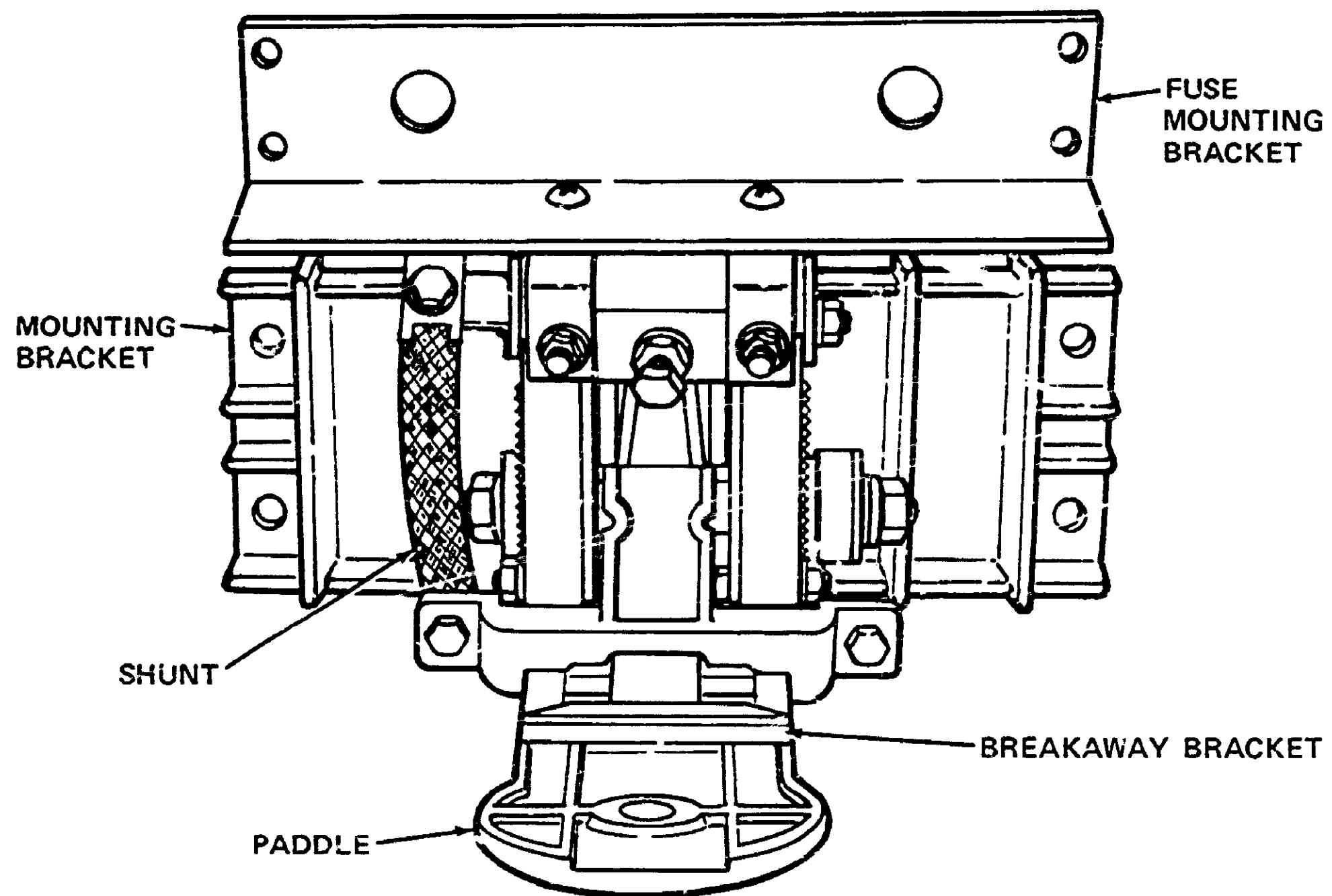
The four accidents involving fires in the current collectors of R-46 cars are described below.

Investigation E

At 1:37 p.m., on April 21, 1981, an eight-car northbound "E" train on track D-4 experienced an undesired emergency application of the train brakes. A towerman and road car inspector on duty at the Roosevelt Avenue Station reported that the train blew the circuit breakers to third rail power as it was leaving the station. From the station platform, they reported that they heard an explosion and observed fire and smoke on the train, which stopped approximately 600 feet north of the station. The passengers heard explosions (some passengers thought as many as five), saw the flames and smoke, and thinking they were about to be engulfed by flames started breaking out end door windows (the end doors of the cars were modified by NYCTA to keep them locked). Eleven windows of the train were broken out. Passengers then began to scramble through the windows jumping down to the track level; a few fell from the windows to the track. The passengers began to walk through the dark, smoke-filled tunnel to the Elmhurst Avenue station.

At 1:44 p.m., the power to the third rails of tracks D-2 and D-4 was shut off and the tunnel ventilation blowers were turned on. At 1:49 p.m., power was also shut off from

^{8/} The truck is the frame which contains each set of wheels of a rail rapid transit car.



CURRENT COLLECTOR

Figure 7.-- Diagram of a current collector.

track D-3. Trains on the D-2 track and the D-4 track stalled south of Roosevelt Avenue when the power was shut off. Another train stalled on the D-3 track south of Elmhurst Avenue, for the same reason.

At 1:57 p.m., 20 minutes after the fire began, the fire department arrived and assisted in evacuating passengers from the burning car. Emergency medical service was requested for passengers at the Roosevelt Avenue and Elmhurst Avenue exits. At 1:58 p.m., passengers were still climbing out of the northernmost cars of the disabled train. At 2:03 p.m., 26 minutes after the fire began, the fire was extinguished. At 2:08 p.m., 31 minutes after the fire began, NYCTA officers and the fire department began to evacuate passengers from the stalled train on track D-2 onto the tunnel catwalk and through an emergency exit to the street above. At 2:22 p.m., passengers on the stalled train on track D-3 walked across train seats bridged between their train and another train. They exited via the catwalk through the emergency exit to the street. At 2:42 p.m., 1 hour and 5 minutes after the fire began, all passengers had been evacuated from the tunnel. At 3:10 p.m., 1 hour and 33 minutes after the fire began, power had been restored to all tracks and service resumed. During this emergency, more than 1,000 passengers were on the three trains in the smoke-filled tunnel; some were reported by NYCTA to be wandering in the trackways unassisted as they attempted to escape the fire and smoke. Twenty-four passengers, including two pregnant women and a man with a heart condition, were treated for smoke inhalation at the nearby Elmhurst City hospital.

The fire originated at the current collector, which had broken loose and grounded against the car truck frame. The current collector was destroyed and the grounding caused an arc and flash up the side of the car which burned the truck side frame, cables, air pipes, and rubber air bag. 9/

Investigation F

At 11:47 a.m. on May 6, 1981, an eight-car northbound "E" train had an undesired emergency application of the train brakes as the train was entering the Hudson Terminal. The train stopped with six cars in the Hudson Terminal Station. A great deal of smoke and flames were coming from under the seventh car in the train. Power was shut off from the third rail and the fire department was notified. Passengers were discharged from the train onto the station platform.

At 11:57 a.m., 10 minutes after the fire began, the fire department arrived. At 12:15 p.m., 28 minutes after the fire began, the fire was extinguished and the fire department subsequently departed.

Power was restored at 12:19 p.m., 32 minutes after the fire began, and service was resumed.

The fire had originated at the current collector, which had broken loose and grounded against the car frame. The fire destroyed the current collector and burned the truck side frame, cables, air pipes, and rubber air bag.

Investigation G

At 2:09 p.m. on May 15, 1981, an eight-car northbound "F" train was leaving the Lexington Avenue Station when the motorman heard an explosion and stopped the train.

9/ The rubber air bag, located under the car, on top of the truck, acts as a suspension cushion for the car body. Air in the bag increases or decreases in response to the passenger load.

When he attempted to restart the train, another explosion occurred and the motorman then placed the train brakes in emergency. The second car was burning and smoke was issuing from under the car. The motorman of another train that entered the Lexington Avenue Station observed the heavy concentration of smoke and attempted to contact command center. When his attempts were unsuccessful, he continued through the station without stopping in order to avoid exposing his passengers to the danger of the smoke environment.

The passengers on board the disabled train panicked and trampled each other as they tried desperately to kick open the train end doors. Unable to open the locked doors of the dark, smoke-filled cars, the passengers then stood on the seats and began kicking out the windows. The crewmembers eventually were able to open the doors and the passengers were evacuated from the train. Fourteen passengers were treated at the scene and two were taken to the hospital for treatment of injuries received when they were trampled during the panic.

At 2:13 p.m., 4 minutes after the fire began, a superintendent at the scene unsuccessfully attempted to extinguish the fire with a fire extinguisher. Because of heavy smoke, the fire department was called. The fire department arrived at 2:22 p.m., 13 minutes after the fire began, and the fire was extinguished at 2:31 p.m., 22 minutes after the fire began. At 2:49 p.m. the fire department departed. At 3:09 p.m., power was restored to the third rail and at 3:24 p.m., 1 hour and 15 minutes after the fire began, service was resumed.

The fire had originated at the current collector which had broken loose and grounded against the car frame. The fire destroyed the current collector and burned the truck side frame, cables, air pipes, and rubber air bags.

Investigation H

At 9:39 a.m. on July 29, 1981, an eight-car southbound "E" train was at the 34th Street Station when the motorman reported an explosion and fire under the third car. The passengers were discharged onto the station platform. At 9:42 a.m., a train on an adjacent track had the train brakes apply in emergency. The passengers on the second train heard an explosion and smelled smoke. Unaware that the fire was on the other train, the passengers on the second train unsuccessfully attempted to open the end doors, and then started breaking out the windows to get off the train.

At 9:50 a.m., 11 minutes after the fire began, the fire department arrived and at 10:01 a.m. the power was removed from the third rail. At 10:16 a.m., 37 minutes after the fire began, the fire was extinguished and the fire department departed shortly afterward. No injuries were reported.

The fire had originated at the current collector of the first train. The current collector had broken loose and grounded against the car truck frame. The fire destroyed the current collector and burned the truck side frame, cables, air pipes, and rubber air bags.

Analysis and Tests

The current collectors involved in the four subway train fires were manufactured by Profabeo and installed by NYCTA on R-46 cars to replace current collectors manufactured by the Ohio Brass Company.

Following the first three accidents investigated, NYCTA performed tests to determine the performance of the Ohio Brass and Profabco current collectors under high voltage arcing. The object was to cause the two types of current collectors to arc and burn and to compare the observed results. The first Ohio Brass current collector tested could not be made to arc. In a second test with an Ohio Brass current collector modified to produce arcing, the unit burned with emission of a light, white smoke. The Profabco current collector burned readily under the same test conditions, emitting a large volume of dense, black smoke. NYCTA concluded that "The Profabco unit generates more fire and dense smoke when compared to the Ohio Brass unit." ^{10/}

Following the third current collector fire, NYCTA also engaged the General Electric Company to perform a failure analysis on eight failed current collectors, including three of those involved in the subway train fires investigated by the Safety Board. Six of the eight failed current collectors were Profabco units and two were Ohio Brass units.

On June 17, 1981, General Electric submitted to NYCTA its report analyzing the eight current collector failures. ^{11/} The analysis found that four of the six Profabco failures, including the fires described in Investigations E, F, and G, involved a broken or failed shunt resulting in arcing and flashover. The fifth failure resulted from the shunt contacting another conductive component, with a subsequent foreign object strike resulting in flashover. The sixth failure involved a broken bolt which allowed the collector paddle to strike a foreign object, resulting in a force which broke the plastic mounting bracket and tore the collector from the truck.

One of the Ohio Brass failures reportedly resulted from a failed shunt. The report noted that the Ohio Brass unit "did not go to complete destruction." The second Ohio Brass failure involved a foreign object which tore the shunt and broke the mounting bracket, leaving the current collector hanging from the car.

General Electric concluded that the major failure mode was failure of the shunt, and found "evidence that 600 volts seeking ground is involved in all major failures and some secondary failures." Secondary failures included accidents that pull the current collector from the car, and steel washers or foreign objects bridging insulation barriers and establishing a conductive path through current collector components. The report stated that some of the metal parts of the current collectors "are sufficiently close to another [ground] potential that any arcing (and the resulting ionized air) cause flashovers."

Evolution of R-46 Car Current Collector Problems

NYCTA introduced a new fleet of 754 R-46 cars into service in July 1975. The R-46 cars subsequently began to develop problems which led to the initiation of a "Section 107" ^{12/} investigation in July 1979 by the Urban Mass Transportation Administration (UMTA), the agency which had financed 80 percent of the cost of the cars through Federal grants. In April 1980, UMTA's investigative team reported that the R-46 car trucks, which were a new and unique design, were experiencing greater levels of vibration than they were designed to withstand. The investigative team's report also noted that problems were occurring with the cars' current collectors, which were attached to the trucks, and that modifications of the current collectors had contributed to the problems.

^{10/} NYCTA letter to the Administrator, Urban Mass Transportation Administration, dated August 18, 1981.

^{11/} "Inspection of Damaged Contact Rail Collectors for New York City Transit Authority" (undated), with transmittal letter dated June 17, 1981.

^{12/} So designated after Section 107 of the National Mass Transportation Assistance Act of 1974 (P.L. 93-503), which requires UMTA to investigate unsafe conditions which create a serious hazard of death or injury in federally-funded mass transit systems.

The R-46 cars originally were equipped with current collectors manufactured by the Ohio Brass Company. The collector paddles were designed to allow for normal vertical movement experienced as they rode on top of the third rail, but to break off if they encountered an unusual lateral or endwise force; for example, a foreign object in the trackbed. This breakaway feature, provided by a shear mechanism called a breakaway bracket attached to the paddle, was designed to avoid transmitting excessive stress to the current collector and mounting bracket. However, the excessive vibration of the R-46 trucks, on which the current collectors were mounted, was found to be causing the current collector paddles to break off frequently. This was one of the safety problems identified by UMTA's investigative team, which reported: 13/

... various components of the current collector assembly have either fractured or failed resulting in unsafe fire conditions. These failures include fractures of the mounting bracket and drive pin, miscellaneous loose and worn hardware, and failures of the shear mechanism. Some modifications of the current collector assembly have contributed to the problem. These fractures and failures have, a number of times, resulted in high voltage grounding and arcing. Therefore, the potential for vehicle and/or right-of-way fires is greatly increased by such occurrences. 14/

UMTA's report officially identified the current collector problems as one of the "unsafe conditions" associated with the R-46 cars, and concluded that:

... the current collector assembly problems (failures) are primarily the result of high levels of truck vibration. There is some indication that other technical factors related to the current collector assembly may also contribute to these problems. Therefore, further analysis of the design of the current collector assembly, and what effect it may have on the failure problem is necessary. However, all major concerns with the current collector assembly should be resolved with the implementation of either of the corrective actions identified [to correct the truck vibration problem] . 15/

As a result of its investigation, UMTA recommended that deficiencies in the current collectors be corrected expeditiously, but did not specify what corrective action should be taken.

The authority and responsibility to investigate unsafe conditions is delegated to UMTA by the Secretary of Transportation. That authority, Section 107 of the National Mass Transportation Assistance Act of 1974, provides in full:

The Secretary of Transportation shall investigate unsafe conditions in any facility, equipment, or manner of operation financed under this Act which create a serious hazard of death or injury for the purpose of determining its nature and extent and the means which might best be employed to correct it. If the Secretary determines that such facility, equipment, or manner of operation is unsafe, he shall require the State or local public body or agency to submit to the Secretary a plan for correcting the unsafe facility, equipment, or manner of operation, and the Secretary may withhold further financial assistance to the applicant until such plan is approved or implemented.

13/ "Report to the Administrator, Urban Mass Transportation Administration, on the Section 107 Investigation of the R-46 Cars, New York City Transit Authority," April 4, 1980, pp. 2-9 to 2-10.

14/ Ibid.

15/ Ibid.

On October 26, 1979, NYCTA submitted to UMTA a corrective action plan for the unsafe conditions identified by UMTA in NYCTA's R-46 subway cars. After subsequent discussions with UMTA, NYCTA submitted a revised, updated plan on June 30, 1980. The plan described both interim corrective actions and permanent solutions. The interim corrective actions specified for the current collector problems were:

To maintain safe operation, parts of the current collector assembly which are found during inspections to be missing, worn or failed are replaced. Since only one current collector per side per car is required, up to two current collectors per car (one on each side) are being removed when parts are not available. New R-46 current collector assemblies have been purchased, and as delivery is made, the missing current collectors are replaced.

To reduce the incidence of missing contact shoe paddles, the Car Maintenance Department is tack welding the shear mechanism bracket [breakaway bracket] to the body of the current collector, thereby overcoming the problem caused by vibration. The tack welding somewhat changes the design characteristics of the shear mechanism. This is considered satisfactory, as none of the Authority's current collectors on other cars have this shear mechanism feature and provide reliable service.

As a permanent solution to the current collector problems, the plan stated:

The complete current collector assembly on the truck will be replaced with the identical arrangement that exists on the authority's standard R-44 type truck and which has been operating satisfactorily.

(The current collectors on R-44 cars are another model manufactured by the Ohio Brass Company.)

On August 11, 1980, UMTA wrote to NYCTA that the plan had been reviewed and UMTA approved it with certain specific and general conditions, none of which pertained directly to the current collector. Among the general conditions, however, was the following requirement:

The NYCTA must expeditiously submit to UMTA for approval, before implementation, any future revisions to the Corrective Action Plan which will result in deviations from the course of action identified in the June 30, 1980 plan.

Another general condition was that NYCTA submit to UMTA quarterly reports containing specified information, including a summary of the past quarter's activities and progress, an outline of the next quarter's activities, and any anticipated problems.

Following the welding of the breakaway bracket to prevent the loss of paddles, another problem began to develop. With the breakaway feature eliminated by the welding, any unusual force encountered by the current collector paddle was transmitted to the current collector mounting bracket, and the mounting brackets began to crack. As this continued, the failure of the mounting bracket would cause the entire current collector assembly to fall off and ground the car, resulting in electrical arcing and fire.

To solve the problem, NYCTA decided to replace the current collectors on R-46 cars with larger current collectors having heavier mounting brackets. NYCTA selected the firm Profabco to manufacture the new current collectors, which were installed on nearly all of the R-46 cars. The Profabco model eliminated the breakaway bracket entirely.

NYCTA's first quarterly progress report, submitted to UMTA on November 7, 1980, described the progress of all corrective actions except those that were specified in the June 30, 1980 plan for the current collectors. The only mention of the current collectors in the quarterly report was a statement that the truck replacement program "will be the permanent solution to the truck cracking and vibration problems and related component problems, including...the current collector." The next quarterly report, submitted February 13, 1981, contained no mention of the current collector.

The first current collector fire occurred on April 21, 1981. Eight days later, on April 29, NYCTA officials met with Safety Board investigators and UMTA representatives. At this meeting, UMTA learned for the first time that NYCTA had engaged Profabco to manufacture a new model of current collectors, and that this new model had been installed on almost all of the R-46 subway cars. Within a month, two more current collector fires occurred, on May 6 and May 15, 1981.

The last item in NYCTA's next quarterly report to UMTA, submitted on May 22, 1981, concerned the current collector:

The Authority is currently investigating a recent fire on car number 826 [the April 21, 1981 fire]. A preliminary investigation reveals that the destruction of the current collector assembly was a result of high voltage arcing in the truck lead area which in turn caused the destruction of the current collector assembly and other parts of the truck and car body. A more detailed analysis of the truck wiring will be made when the truck is removed from the car body.

On June 3, 1981, NYCTA sent UMTA a supplemental report to the May 22 quarterly progress report. This supplemental report was devoted almost entirely to the current collectors. The report described the welding of the breakaway bracket and other modifications that were made to the original Ohio Brass current collectors because of failures due to truck vibration, and identified differences between the Ohio Brass and Profabco units. The report stated that NYCTA was developing a detailed inspection and repair procedure for the current collectors, and as an interim measure all current collectors were being inspected twice weekly for broken welds or cracks and signs of frayed shunts and loose or missing hardware. In addition, all current collectors had been equipped with double shunts. The report also indicated that a structural analysis was to be performed on the existing current collectors and a proposed new unit, and that the General Electric Company had been engaged to analyze current collector failures.

About 2 months after NYCTA submitted its supplemental report to UMTA, on July 29, 1981, the fourth subway train fire involving a Profabco current collector occurred.

On August 18, 1981, NYCTA submitted its next quarterly progress report. The report forwarded a copy of the General Electric Company's failure analysis and indicated that NYCTA would install an insulating boot over the ends of the current collector bracket and mounting bolts, as the G.E. report had recommended. It also described the fire tests conducted on the Ohio Brass and Profabco current collectors and reiterated much of the information included in the June 3 supplemental report.

The four current collector fires on April 21, May 6, May 15, and July 29, 1981, all involved the current collectors manufactured by Profabco. Subsequent investigation revealed that Profabco had never designed or manufactured a current collector prior to being selected by NYCTA to manufacture them for the R-46 subway cars. No industrywide standards, criteria, specifications, or guidelines exist for the design and manufacture of current collectors. The design of each model now in use was developed individually by the companies that manufactured them.

SURVIVAL ASPECTS

NYCTA, in coordination with city fire and police departments, emergency medical services, and other emergency response organizations, has developed an interagency agreement which specifies detailed procedures for responding to NYCTA emergencies. ^{16/} All employees are required to follow the procedures when an emergency occurs.

Notification of Fire Department

Section 10.2.1.1.1 of the emergency procedures provides that in the event of a fire in or under a train, the Desk Trainmaster, located in the NYCTA Command Center, will notify all NYCTA operating departments and the Transit Police Department via intercom and will dispatch NYCTA personnel to the scene of the emergency. The following section (10.2.1.1.2) provides that "The Command Center will also immediately notify the appropriate Fire Department Dispatcher . . .," and specifies the information to be provided to the fire department.

Under procedures for fires and smoke in tunnels, Section 10.1.1.1.1 provides that:

All fire and smoke conditions will be reported to the Desk Trainmaster who will immediately announce the fire: via intercom to all NYCTA operating and other departments; by direct line telephone to the NYCTA Power Department System Operator of the respective division (IRT or BMT-IND); and by direct line telephone to the appropriate New York City Fire Department Borough Dispatcher(s), and the Emergency Medical Services.

Section 10.1.1.1.3. provides that:

The Desk Trainmaster will gather and evaluate data (in addition to the regularly reported information) pertaining to the extent and intensity of the fire, and determine whether or not the fire can be extinguished with available manpower and equipment. This information will be made available to the responding Fire Department Officer-in-Charge.

In the eight train fires investigated, the time interval between the onset of the accident and notification of the Fire Department by NYCTA ranged from 4 minutes (Investigation F) to 42 minutes (Investigation B). In four of the accidents (Investigations A through D), a trainmaster, motorman instructor, or road car inspector was sent to the scene to investigate and report before the fire department was notified. In these accidents, the fire department arrived 34 minutes, 59 minutes, 33 minutes, and 36 minutes, respectively, after the onset of the fire.

In the case involving the longest interval, the fire began as the train was standing in a station, and passengers were discharged onto the station platform. The motorman then attempted to move the train to a layup track; however, an uncontrolled application of the train brakes stopped the train en route in a tunnel, and the train could not be moved. A road car inspector sent to investigate arrived at the train 24 minutes after the onset of the fire. Fourteen more minutes lapsed before the road car inspector requested that the fire department be notified, and another 4 minutes passed before the call was made by the Transit Authority Police Control Center. No passengers were on the train after it left the

^{16/} NYCTA Interagency Standard Operating Procedure No. 1, "Response to NYCTA Emergencies," August 25, 1975.

station; however, at least one passenger train passed through the tunnel where the disabled train was on fire, and the motorman of the passing train reported a very heavy smoke condition.

In Investigations E through H, the fire department was notified either by passengers evacuated at stations or by NYCTA personnel within 15 minutes after the fire was detected. In these cases, the fire department arrived 20 minutes, 10 minutes, 13 minutes, and 11 minutes, respectively, after the onset of the fire.

Passenger Evacuation

Section 10.2.1.1.5 of NYCTA emergency procedures provides that "Whenever possible, trains should proceed to and remain within station limits during attempts to extinguish the fire. Passengers should be discharged when train stands within station limits."

Four of the train fires occurred when trains were entering or standing in a station (Investigations B, D, F, and H). In these cases, passengers immediately were evacuated onto the station platform. 17/

In one case, the fire disabled the train as it was leaving the station, with two cars at the station platform and eight cars in the tunnel (Investigation C). Passengers in the two rear cars were evacuated onto the station platform, but the conductor was unable to reach the passengers in the forward cars because of the fire and smoke. The motorman tried unsuccessfully to release the train brakes so the train could be moved into the station to evacuate the remaining passengers. A motorman instructor who arrived at the scene 31 minutes after the fire was reported, also tried unsuccessfully to release the train brakes. Forty-six minutes after the fire began, the motorman instructor began to evacuate the remaining passengers onto the tunnel catwalk and through an emergency exit to the street. Fire department units arrived at the scene 33 minutes after the fire began and assisted in the evacuation, which was completed 56 minutes after the fire was reported.

"Procedures for Mass Passenger Evacuation from Trains," Section 10.4.1.1.6 provides that:

The order to evacuate will only be given by one of the following: the Command Center; Chief of Operations, RTTD; 18/ the Assistant General Superintendent, RTTD; a senior operations officer; or the designated RTTD Supervisor at the NYCTA Command Post; except that the traincrew will evacuate passengers immediately if danger is imminent. All available personnel must be utilized to assist in the evacuation. Directions must be given to use ladders (mounted at every blue light in river tubes, in emergency rooms and at stations) to enable passengers to descend from the train to the roadbed. The ladder must be secured as firmly as possible, using rope when feasible. An employee must be stationed at the bottom of the ladder to hold it steady and help passengers off, and another employee must be stationed at the top of the ladder to help passengers onto the top rung.

17/ NYCTA emergency procedures define an "unscheduled removal of passengers from an immobilized or disabled train" as an "evacuation" if passengers are removed directly onto the tracks or through an emergency exit, and as a "discharge" of passengers if the passengers exit directly onto a station platform or through other trains onto a station platform. For the purposes of this investigation, any removal of passengers from a train under emergency conditions is considered an evacuation.

18/ NYCTA's Rapid Transit Transportation Department.

NYCTA employees receive classroom instruction in the emergency procedures, but do not receive a copy of the standard operating procedures document to keep for reference. NYCTA also conducts emergency drills in which the fire department practices subway firefighting operations. However, motormen and conductors do not participate in emergency drills or receive "hands on" training in how to carry out their assigned responsibilities under the emergency procedures (for example, evacuating passengers by various methods and using fire extinguishers).

On April 16, 1981, NYCTA opened a firefighting training center which provides "hands on" training to employees in the proper use of different types of fire extinguishers for different types of fires, how to use firefighting equipment, and how to manually shut down track power from an emergency station. Employees also are taught how to safely evacuate passengers using train seats as a bridge to an adjacent train and to use ladders to evacuate passengers to the trackbed from the ends of trains. NYCTA intends to give the training to 26,000 employees. From the date the firefighting training center opened through July 1981, 302 employees of all departments had been trained. The first participants were department supervisors. Motormen and conductors have yet to attend the school, and a training schedule has not yet been established for motormen and conductors.

In three cases, the train fires disabled the train in a tunnel. In one case (Investigation A), another train was used as a bridge for the passengers in the four rear cars of the train on fire to move through the end doors of cars and evacuate onto the station platform. The evacuation of these passengers began 10 minutes after the fire started and was completed 21 minutes after the fire started. Passengers in the car on fire had been evacuated into the forward cars, and the motorman and a trainmaster were able to separate the forward cars from the disabled car and move that portion of the train to a station, where the remaining passengers could be evacuated onto the platform. The elapsed time from the beginning of the fire to the completion of the evacuation was 28 minutes. When fire department units arrived at an NYCTA station 6 minutes after the last passenger had been evacuated, 34 minutes had elapsed since the fire started.

In three of the train fires, an unplanned evacuation was precipitated when passengers who were locked in subway cars broke car windows to escape from burning trains, from other trains that were exposed to the smoke environment, or both. These cases include the second and third of the three accidents in which the train was disabled in a tunnel (Investigations E and G) as well as one of the previously described accidents in which passengers in the train on fire were evacuated onto a station platform (Investigation H); in the latter case, however, passengers evacuated a nearby train in panic.

In Investigation E, the passengers heard multiple explosions and saw flames and electrical arcing reaching up the side of the car on fire. They attempted to exit the train, but found that all the doors of the cars were locked. In panic, the passengers smashed out windows to escape. Eleven windows of the train were broken out. The passengers began scrambling through the broken windows and jumping to the trackbed below; a few of the passengers fell from the windows to the track. The passengers began to walk through the dark tunnel to the next station, surrounded by dense, black smoke. It was not until three minutes after passengers began jumping out of the cars that power to the track was shut off. Eight minutes after passengers began evacuating the train, the Desk Trainmaster requested the fire department to respond. Firefighters arrived at the scene 20 minutes after the fire began and helped passengers evacuate the burning car, as passengers continued to climb out of the windows of other cars of the train.

Thirty-one minutes after the fire started, firefighters began evacuating passengers from another train that was stalled in the tunnel. By that time the fire had been extinguished. Forty-five minutes after the fire began, passengers on another stalled train walked across train seats bridging the gap between their train and the train that had just been evacuated and exited onto the tunnel catwalk and through an emergency exit to the street.

Sixty-five minutes elapsed from the start of the fire until all of the stalled trains were evacuated. During the emergency, more than 1,000 passengers were on the trains in the smoke-filled tunnel, and some were reported by NYCTA to be wandering around unassisted in the trackways as they attempted to find a route of escape from the fire and smoke. Twenty-four passengers were treated for smoke inhalation at a nearby hospital.

In the fire described in Investigation G, the passengers on board the disabled train in the tunnel, finding all of the car doors locked, panicked and trampled each other as they tried desperately to kick open the train doors. Unable to force the doors open, the passengers stood on the seats and began kicking out the train windows. Crewmembers eventually were able to unlock the end doors and the passengers were evacuated. Fourteen passengers were treated at the scene, and two were taken to the hospital.

In Investigation H, the train on fire was at the station and passengers were evacuated immediately onto the station platform and through station exits. Three minutes later, however, a train on an adjacent track had the train brakes apply in emergency. The passengers on that train heard an explosion and smelled smoke. Unaware that the fire was on the other train, the passengers attempted to exit their train. When they found that all the doors of the cars were locked, they panicked and started breaking out windows to escape the train. All of the passengers on that train were evacuated successfully and no injuries were reported.

All of the fires in which panicking passengers precipitated an evacuation involved R-46 cars; however, the cars in which the end doors could not be opened by passengers included both R-44 and R-46 cars. These cars originally were equipped at each end door with a motion detector which would keep the door locked while the train is in motion, but would unlock the doors if the train was not in motion. NYCTA encountered repeated failures with the motion detectors and decided in 1979 to modify the doors to keep them locked. By October 1980, this modification was completed on all R-44 and R-46 cars. While passengers cannot open the locked end doors on these cars, the doors can be unlocked electrically from the motorman's position, the conductor's position, or any other operating compartment of any car. In addition, any end door can be opened with a key carried by motormen and conductors.

There are no instructions posted in NYCTA cars to inform passengers what to do in the event of a fire or other emergency. There are no instructions to tell passengers when to evacuate, how to exit cars, where emergency equipment such as ladders, fire extinguishers, and emergency phones is located, or how to find an emergency exit.

On January 2, 1981, the Assistant General Superintendent of the NYCTA Rapid Transit Transportation Department recommended that NYCTA place decals on or near the end doors with the following inscription:

Attention passengers. In the event of an emergency, these doors will be automatically unlocked by the crew.

He suggested that, "This may forestall incipient panic among passengers in cases of emergency where evacuation of a car becomes desirable." ^{19/} As a result of this recommendation, NYCTA opened bids for production of 3,300 decals for R-44 and R-46 car end doors on May 26, 1981.

On January 6, 1981, the Rapid Transit Transportation Department issued a bulletin ^{20/} to motormen, conductors, and other employees, instructing that if a train becomes stalled and a fire/smoke condition is observed or reported, they must:

1. Notify the command center.
2. Use the train public address system to reassure passengers and maintain calm.
3. Attempt to recharge the train brakes and move into the nearest station.

The bulletin stated that if the attempt to move the train failed, the traincrew must unlock all of the end doors from one of the operating compartments.

On April 29, 1981, Safety Board investigators met with representatives of NYCTA and UMTA. During the meeting, participants discussed the problem of providing a means of exit in an emergency, operable by passengers in R-44 and R-46 cars, without creating the potential for fatalities from passengers using the doors under nonemergency conditions and falling between the cars of a moving train while attempting to pass from one car to another. The representatives of UMTA and NYCTA and Safety Board investigators discussed the possibility returning to use of motion detectors that keep the doors locked while a train is moving and automatically unlock the doors when a train is stopped.

On June 3, 1981, the president of NYCTA informed UMTA's Administrator in a supplemental progress report on the R-46 corrective action program that a schedule was being developed to install motion detector circuitry in all R-44 and R-46 cars between June 1982 and July 1983. This schedule was reconfirmed in a subsequent progress report dated August 18, 1981.

Section 10.2.1.1.4 of the emergency procedures provides that in the event of a fire in or under a train:

The traincrew involved in the incident will attempt to extinguish the fire, if practicable. The traincrew should try to contain the fire by deactivating affected equipment such as motors, generators, compressors, air conditioners, etc. If fire burns through an air hose of the car, the condition should be treated as a brake pipe rupture.

However, the emergency procedures do not indicate how a brake pipe rupture should be treated. Presumably, a brake pipe rupture would require cutting away the car in trouble so that the portion of the train ahead or behind it would be operable. In Investigation A, it took 25 minutes to cut away the disabled car to evacuate the passengers.

Emergency Equipment

None of the NYCTA subway cars are equipped with fire extinguishers. According to NYCTA officials, until about 2 years ago each car was equipped with a

^{19/} Memorandum to General Superintendent, Rapid Transit Transportation Department, January 2, 1981.

^{20/} Bulletin No. 1:81, January 6, 1981.

fire extinguisher. However, because of vandalism and theft, NYCTA no longer puts fire extinguishers in the cars.

Dry chemical extinguishers are located at all emergency alarm boxes, which are spaced about 600 feet apart along the north or west wall of a subway tunnel (or along both walls in underriver tunnels) and are identified by a blue light. Fire extinguishers are also provided in emergency equipment rooms located at both ends of an underriver tunnel. Emergency ladders for evacuating passengers to the trackbed from the end doors of trains are also available at emergency alarm boxes; there are no ladders in or on subway cars.

Wet standpipe systems are supplied by city water mains at both ends of 10 underwater tunnels; the 3 underriver tunnels have dry standpipe systems, spaced about 200 feet apart, which the fire department can connect to hoses through special connections at street level to charge the standpipe systems with water. Virtually all of the standpipe systems in the underwater tunnels are equipped with fire hoses and nozzles.

In several of the cases investigated, firefighters connected their hoses to a water supply at a subway station and formed a "hose line" to the location of the fire, or connected their hoses to a water supply at street level and formed a hose line into the subway through an emergency exit. In Investigation A, it took 24 minutes after firefighters arrived (58 minutes after the fire started) to form a hose line to the fire. In Investigation B, firefighters arrived 59 minutes after the fire started (they had been called by NYCTA 42 minutes after the fire started) and began looking for exits through which they could put a hose line. Fifty minutes later (1 hour, 39 minutes after the fire began) a hose line was established from a subway station.

Most of the ventilation equipment in NYCTA tunnels was installed more than 40 years ago. In the aftermath of at least two of the train fires investigated (Investigations B and D), NYCTA ordered trains to "run light"--without passengers--through the tunnels to help clear away the smoke which remained in spite of the activation of ventilation fans.

Exposure of Passenger Trains to Fire and Smoke Conditions

Section 10.1.1.1.2 of NYCTA emergency procedures provides that, in the event of fires or smoke in tunnels:

Trains on the affected track(s) that are able to move must be allowed to proceed out of the area. No additional trains should be allowed on the affected track(s) in the area.

Section 10.1.1.1.12 provides that:

Motormen operating air-conditioned trains or cars will not enter dense smoke areas with the air-conditioning operating. Motormen must press the momentary switch to the "OFF" position. When trains have cleared the smoke area, motormen may restart the air-conditioning.

In at least one case (Investigation D), a passenger train entered the area and passed the disabled train 30 minutes after the fire started. The motorman reported that the smoke was so dense he could not see the wayside train signals.

The emergency procedures absolutely prohibit trains from entering areas where power is or may be shut off--particularly when the fire department is responding, since the fire department insists that power be shut off before firefighters are sent in.

ANALYSIS

Fires, particularly on trains in tunnels, are potentially the most hazardous occurrences in rail rapid transit systems. Considering that at peak passenger loads a subway train can carry 2,000 or more passengers, the loss of life in a single fire in the confined spaces of underground tunnels could be catastrophic.

The Safety Board's special investigation of eight major fires on NYCTA subway trains over a 13-month period revealed serious and pervasive safety problems which, unless corrected, could lead to the most tragic consequences. These problems include gross and recurring inadequacies in NYCTA's car maintenance program; insufficient capability to identify recurring safety problems and bring them to the attention of the management before they result in accidents; safety improvement actions which are ineffectual or which result in more serious hazards than those they are intended to correct; and serious deficiencies in emergency preparedness. Compounding these problems is the lack of any effective, systematic process of checks and balances to see that safety problems are, in fact, identified and resolved effectively.

Motor Control Group Fires

As the investigation of the four motor control group fires progressed, it became obvious that these fires were occurring following maintenance inspections which were performed to prevent precisely these problems from occurring. The December 10, 1980, motor control group fire occurred 9 days after the car's motor control group received a "C" inspection--the most comprehensive inspection conducted by NYCTA, which includes cleaning, adjusting, and testing; the June 25, 1980 motor control group fire occurred 25 days after a "C" inspection, and the lack of any evidence of the missing line breaker switch cover at the accident site suggests that it was either not replaced, or replaced so loosely that it fell off, after being removed by maintenance personnel the day before the accident; the December 11, 1980 fire involved a car that had remained in passenger service for 7 days after it had been ordered off the road for correction of motor control group problems; and the fire on April 29, 1981 occurred the day after the car was in the shop for correction of motor control group problems which were certified as having been repaired when, in fact, they had not been.

The maintenance program deficiencies disclosed by this investigation included poor performance of inspections and maintenance, inadequate maintenance supervision and surveillance, inadequate quality assurance inspections, insufficient training for car repairmen and quality assurance personnel, the lack of effective systems for identifying and communicating safety-related equipment problems to NYCTA management and directing the car maintenance program to adequately address car maintenance needs. These deficiencies, which violate principles of preventive maintenance, cannot be considered isolated failures. They are indicative of gross inadequacies throughout the car maintenance program. They are all the more disturbing in view of the fact that these inadequacies have not suddenly appeared; they had been identified before.

On August 2, 1979, the Safety Board issued the findings of its investigation of four NYCTA subway train derailments which occurred within a 4-month period ending March 21, 1979. Each of the derailments resulted from a cracked wheel which had resulted from extensive overheating. Contributing to the cause of the overheating in each case was the partial application of a handbrake. The wheels of three of the cars had been inspected (respectively) 1 1/2, 4, and 18 days prior to the derailments. In one case, a road car inspector was dispatched to investigate a motorman's report of a problem, but performed only a cursory inspection and found nothing unusual; moments later, the train derailed. The Safety Board concluded that "Because of a lack of adequate inspection

procedures, the New York City Transit Authority employees failed to detect the partially applied handbrake and the thermally damaged wheels before they cracked." These conditions had been brought to the attention of NYCTA's management during the investigation of the first derailment and the Board believed that adequate action would be taken to correct the problems. After the second derailment, recommendations were sent to the Metropolitan Transportation Authority (MTA), the agency having authority over NYCTA. Before adequate action was taken, the third and fourth derailments occurred.

While the problems in NYCTA's maintenance program which were identified more than 2 years ago have continued, and may even have increased, NYCTA management actions to correct the problems have proven ineffectual to date. The four motor control fires began occurring immediately after NYCTA issued a Standard Inspection Procedure specifying uniform procedures for motor control group inspections; and the fourth accident occurred after NYCTA, in the wake of three train fires, adopted procedures for increased surveillance of motor control group inspections and repairs and initiated special training on the subject for car inspectors, shop foremen, and quality assurance personnel. After more than 2 years, serious problems in NYCTA's car maintenance program still have not been corrected, and even corrective measures aimed specifically at the motor control group--measures in areas ranging from inspection procedures to maintenance training, supervision, and quality assurance--have failed to improve the situation. These continued problems indicate a need for NYCTA to conduct a thorough overhaul of its car maintenance program to improve its effectiveness. Currently, however, there are no national standards or guidelines in existence to assist NYCTA and other rail rapid transit authorities in carrying out a comprehensive, effective maintenance program.

Lack of training has been a serious problem in NYCTA's maintenance program. While NYCTA provides formal training for road car inspectors, quality assurance inspectors and car repairmen typically have only 2 years practical experience and receive only on-the-job training in those assignments. There is no comprehensive, systemwide maintenance training program to develop and maintain the technical competence necessary to the critical function of maintaining the reliability and safety of the subway cars on which the entire system depends. Without such a systemwide program, including both initial and recurrent training and increased surveillance and quality control, the performance and effectiveness of the maintenance program is not likely to improve significantly.

The failure problem of the motor control groups should have been brought to the attention of management much earlier. A system is in place to provide automated data on equipment failures; however, it is not programmed to provide meaningful data which can be analyzed and used to identify recurring or new problems and trends as a basis for preventive action. Safety Board investigators found it necessary to go through a laborious and time-consuming manual search of written records in order to explore the incidence of 'heavy burnups' -- major motor control group fires -- in just one NYCTA division. NYCTA has encountered similar problems in its attempts to obtain useful information from its management information system. In the June 3, 1981 supplemental progress report to UMTA, NYCTA's president stated:

In an attempt to perform an analysis of all train delay reports where current collectors are found to be the cause of train delays, a computer print-out was produced which lists all train delays requiring corrective action involving the current collectors. There were 997 reported incidents since 1976. However, the print-out does not contain sufficient detailed information to permit a proper failure analysis. The Authority has had insufficient time to perform the analysis based on the individual failure reports.

The difficulties encountered by the NYCTA in attempting to obtain useful data from its own system about equipment failures which may affect the safety of passengers underscores the need for and importance of developing a means of obtaining such information.

Data compiled by Safety Board investigators on motor control group heavy burnups on IRT Division cars, extracted from NYCTA shop records but not available from the automated management information system, are particularly illuminating. These data show a steady increase in motor control group heavy burnups since NYCTA increased the interval between scheduled car maintenance inspections from 7,500 to 10,000 miles in October 1978. This appears to be a contributing factor to motor control group heavy burnups.

In an interview, the Superintendent of Maintenance for the Massachusetts Bay Transportation Authority (MBTA) in Boston, which uses the same types of motor control groups as NYCTA, stated that MBTA's scheduled maintenance inspection interval for the motor control groups is 5,000 miles or 1 month, and MBTA has had no fire problems with the units. The Washington Metropolitan Area Transit Authority (WMATA), which also uses these types of units, has an inspection interval of 3,000 miles and also is experiencing no major problems. This experience of other rail rapid transit systems which perform scheduled maintenance inspections far more frequently than NYCTA would indicate that if NYCTA's inspection intervals were reduced, fewer motor control group fire problems would occur, provided that the problems of inadequate inspections and maintenance are corrected.

One particular problem with the motor control group fires, identified during the special investigation, is the contribution of ruptured air lines to the severity of the fire. When the main airbrake lines were ruptured by the fires, they provided an unrestricted flow of air which, like a bellows, contributed to the intensity of the fire and the severity and speed of damage. Similarly, in the accidents involving the Westinghouse motor control group, the severity of the fire and resulting damage was increased by the rupture of the air line to the air-operated cam in the Westinghouse units. This accounts for the far greater incidence of heavy burnups involving Westinghouse motor control groups compared to the electrically-operated General Electric units, when there are nearly the same number of each type in the NYCTA subway car fleet. The additional bellows effect--when the air line of the Westinghouse motor control groups is engulfed in flames and ruptures--causes greater damage, resulting in a greater probability that fires involving these units will lead to a heavy burnup.

The main airbrake line has no connection with the motor control group and could be relocated away from the motor control group to prevent the line from rupturing in the event of fire. The air line to the Westinghouse motor control group cannot be relocated since it provides the air supply to the motor control group. The problem, therefore, is not the location of the air line, but the fact that the flow of air to the fire is unrestricted when the line ruptures. Devices are available which could be installed in the air line to shut off or restrict the flow of air if the line is ruptured. Considering the very serious risks to passengers posed by intense under-car subway train fires and the amount of damage which has resulted from this type of fire, these low-cost improvements would be well-justified.

Current Collector Fires

The four current collector fires illustrate the implementation of actions to correct unsafe conditions resulting in more serious hazards than the problems they were intended to correct. UMTA had identified potential safety problems with the original Ohio Brass

current collectors on the R-46 cars because of the loss of paddles due primarily to excessive vibration of the trucks, and indicated that correction of the truck vibration problem would solve the major current collector problems. However, in welding the current collector breakaway brackets as an interim measure, NYCTA created a more serious hazard than the potential safety problem posed by the loss of paddles. This negated the function of the breakaway bracket--to prevent transmission of excessive stress to the current collector assembly and mounting bracket--with the result that the mounting brackets began cracking. If the bracket cracking were not detected and corrected, the current collector would eventually fall to the trackbed, grounding the car and creating a hazardous fire situation.

NYCTA's next solution, replacing the modified Ohio Brass current collectors with new units, resulted, again, in a more serious hazard. NYCTA engaged a firm with no previous experience in designing and manufacturing such safety-critical equipment. The wholesale introduction of this untried equipment into passenger service on R-46 cars with no prior testing resulted in its being field tested on NYCTA passengers. The four subway car fires which resulted demonstrated the consequences of such a haphazard approach to safety. The sacrificing of preoperational testing to rush equipment into passenger service carries enormous risks.

One of the recommendations made by the Safety Board as a result of its public hearing and evaluation of rail rapid transit safety was that UMTA:

Establish a process, based upon testing and evaluation in accordance with such criteria as the Administration shall establish, for the certification or identification of specific products and materials used in the construction of rail rapid transit cars as meeting minimum safety standards or guidelines, and provide this information to rail rapid transit authorities on a regular basis. (Safety Recommendation No. R-81-11.)

This recommendation was made because there are no national standards, specifications, criteria, or guidelines for the safety performance of equipment and materials used in subway cars. Consequently, each rail rapid transit authority must either accept product information supplied by the manufacturer, or undertake the costly task of performing its own testing or engaging a private firm to perform the testing. The process is further complicated by the absence of safety standards, which makes it necessary for each individual transit authority to conduct the research necessary to identify acceptable levels of safety performance for each product, or to rely on "judgmental analysis" to determine its own safety standards.

In its evaluation report, the Safety Board cited the experience of San Francisco's Bay Area Rapid Transit District (BART) in attempting to identify suitable materials to replace the flammable and toxic materials which had been involved in the fatal subway train fire in the Transbay Tube on January 17, 1979. Before the fire occurred, BART had already selected a replacement material for its subway car seats, using "judgmental analysis." After the fire, BART re-examined its selection and found that the material previously selected would not adequately resolve the problems of flammability and toxicity. Both BART and the Metropolitan Atlanta Rapid Transit Authority indicated that information supplied by manufacturers was not always accurate or reliable. BART examined a materials information bank developed for UMTA by DOT's Transportation Systems Center and found that the information available was not sufficient to guide its selection. BART eventually engaged a firm to conduct a fire testing program for a variety of materials, but still encountered numerous difficulties which complicated its search for a satisfactory material.

In the end, BART had to rely again on "judgmental analysis." A subsequent analysis performed by the staff of the California Public Utilities Commission, a State agency that oversees BART safety, found that, BART's best efforts notwithstanding, the material that BART ultimately selected--and later retrofitted in all of its subway cars--posed flammability and toxicity problems. BART's experience is just one example of individual efforts by transit authorities to identify acceptable safety performance levels and to test products and materials to determine whether they meet the performance levels specified, with little or no assurance that their efforts and the resources and time devoted will be sufficient to produce a satisfactory result.

A certain level of testing by individual transit authorities--for example, preoperational testing of a new rail rapid transit system or a new subway car--is necessary to determine how the system as a whole and its subsystems will perform. However, basic testing of individual products and materials should not have to be duplicated by each transit authority individually, or to depend upon the availability of resources or other factors. A safety certification process would be both more cost-efficient and more safety effective. Such a process could provide for the identification of products which, based upon independent testing, meet or exceed levels of safety performance which are considered desirable. This type of process is not new. It is used for safety and other purposes in a variety of areas including consumer appliances, motor oils, and household furniture.

While safety standards may be made compulsory through statutory or regulatory action by State or Federal authorities, a product safety certification process can be entirely voluntary; desirable safety performance levels can be identified without being required, and the submission of products by manufacturers for independent testing--in accordance with specified uniform testing methods and procedures based on research--can be left to the manufacturer. Even a voluntary safety certification process would provide valuable information to transit authorities about the basic safety performance of alternative products and materials without the need for fundamental testing on a site-by-site basis. While the equipment in many cases may be site-specific, safety performance needs are national and even international in application.

A voluntary safety certification process would not necessarily have prevented NYCTA's introduction of untested equipment into passenger service, but it could have made available information about alternative products, or made available standard testing methods and procedures which might have contributed to a different result.

Survival Aspects

Investigation of the survival aspects of the eight NYCTA subway train fires disclosed serious deficiencies in NYCTA emergency procedures and practices in such areas as emergency training and equipment, reporting of fires to the fire department, passenger evacuation, and exposure of passenger trains to hazardous conditions during emergencies involving fire and smoke. Although NYCTA is taking or plans to take corrective action in some of these areas, further action is needed to reduce the potential exposure of passengers to unnecessary risks in the event of future emergencies.

At the Safety Board's public hearing on rail rapid transit safety in July 1980, an NYCTA motorman testified that NYCTA has never provided adequate emergency training to employees. He stated that NYCTA has emergency procedures on paper, but that employees receive no hands-on training. Other motormen and conductors interviewed during the course of this investigation made the same comment. At the same hearing, a representative of NYCTA management testified:

The success of any operation depends upon the skilled, trained people that we have. The best developed procedures are just so much paper if the personnel that must apply them do not do it effectively.

NYCTA's establishment of a firefighting training center in April 1981 to provide hands-on emergency training to employees was a positive action. However, during the center's first 3 1/2 months of operation, the first 320 NYCTA employees trained were departmental supervisors and not motormen or conductors, who are the only employees immediately at the scene of a fire or other emergency involving a subway train. As of September 21, 1981, conductors and motormen had not yet been scheduled for training.

Conductors and motormen should receive high priority for this type of emergency training because they are the first line of defense for passengers against a fire or other life-threatening emergency involving a subway train. They also are immediately responsible for carrying out NYCTA emergency procedures including reporting the emergency to the Command Center, moving the train to safety if possible, fighting fires, and determining when imminent danger to passengers makes their immediate evacuation necessary. Yet NYCTA motormen and conductors have never been given training or guidelines for evaluating emergencies, determining what constitutes "imminent danger," using firefighting equipment, or evacuating passengers. More than any other employees, subway train motormen and conductors need to know how to effectively carry out these responsibilities. In view of the fact that it may take years to complete the training of motormen and conductors alone (NYCTA's goal of training 26,000 employees would require more than 8 years at the present rate of training), any delay in beginning their training exacerbates an already serious problem. Money budgeted for firefighting training for 1981-82 was \$267,000 and would account for the training of 2,550 students.

With proper training, motormen and conductors could perform a vital role in evaluating an emergency and providing the Command Center essential information. But the current practice is for the train's motorman and conductor to wait for a supervisor to be dispatched to investigate the problem and report back to the command Center, which loses valuable time and may increase the risks to passengers. With two employees already at the scene, there is no reason for such delay, especially when any delay can be critical to the safety of passengers exposed to the hazards of fire, smoke, and panic in the confines of subway cars and tunnels.

Compounding the problem of lack of emergency training is the fact that NYCTA subway trains do not carry fire extinguishers. According to testimony of the International Association of Fire Chiefs at the Board's public hearing, a fire can rapidly escalate to an intensity of 600° to 800° within 6 minutes. Yet, in the critical early moments when a fire is first detected, before a flashover occurs, the only available firefighting equipment is outside the train up to 600 feet away on the tunnel wall. In the time it takes to leave the train, identify the problem, search for a fire extinguisher, and return, it may be too late to be effective. The problem of security for on-board fire extinguishers is certainly a serious one in view of NYCTA's past experience with vandalism and theft. In 1974, it cost \$244,499 to replace and maintain fire extinguishers on board trains. But there are at least two positions in the train which provide a reasonable degree of security--the locked compartments manned by the motorman and conductor. Provision of fire extinguishers at these two positions when a subway train is made up or just prior to dispatch would provide the needed capability to control a fire before a major flashover endangers the lives of passengers.

If a flashover or major fire does occur, effective fire control will probably depend upon the prompt response of the fire department. However, the forces that are best trained and equipped for firefighting and rescue operations may still be at the station,

waiting for an alarm, when a major fire emergency requiring mass passenger evacuation occurs in an NYCTA subway. In four of the eight subway train fires investigated, the fire department response was delayed because NYCTA did not immediately notify the fire department when the fire was detected. These delays are particularly serious because the lack of adequate firefighting water supplies in most of NYCTA's subway tunnels often makes it necessary for firefighters to stretch hose lines from the street or a subway station to reach a fire emergency in a tunnel, further delaying firefighting and rescue operations.

Although NYCTA emergency procedures provide for immediate notification of the fire department, they discourage immediate notification through their emphasis on immediate notification of NYCTA operating departments and dispatch of supervisory personnel to investigate an emergency to evaluate the situation and determine whether the fire can be extinguished with available personnel and equipment. At the Safety Board's public hearing, fire officials questioned the competence of rail rapid transit employees to judge the seriousness of a fire and testified that fire services should be notified immediately any time a fire is suspected. During the current collector fire on July 27, 1981 (Investigation B), NYCTA personnel believed that the fire was subsiding at several points, and the fire department was not notified until 54 minutes after the fire was detected. When the fire escalated later, fire engines had not even left the station because no alarm had been turned in.

Considering the fire potential of a subway system, the lack of trained personnel and firefighting equipment on board NYCTA subway trains, and the fact that help may not be requested promptly, it is particularly important that passengers know what to do in the event of an emergency. However, NYCTA does not provide passengers information on what to expect in an emergency, when and how to escape from a burning subway train, how to find emergency alarm boxes, ladders, and fire extinguishers, or how to safely escape from a tunnel when visibility may be almost totally obscured by darkness and dense smoke. In fact, passengers may be trapped in subway cars with 10 doors, all locked, and no means of escape except by breaking out the windows. Unless passengers are provided adequate emergency information, no amount of reassuring words or a decal informing them that locked doors will be automatically opened when necessary is likely to prevent a panic on a burning train. Even if passengers were reassured and calmed by such information, they could be trapped if the conductor and motorman are disabled, unable to operate the doors automatically, or unable to pass through a rush hour crushload of passengers to open the doors manually. In its investigation of a subway train fire in a Southeastern Pennsylvania Transportation Authority station on September 6, 1979, the Safety Board found that the motorman attempted to reach the side doors of a car to unlock them; however, as soon as the motorman opened the door of his operating compartment, he was pushed back through the compartment's window and safety bar and onto the station platform by passengers who panicked when they found they were locked in the burning subway car. Instructions to passengers to wait for the doors to open could result in a dangerous situation at crushload conditions or if the passengers jam up by the end doors, preventing the inward-opening doors from operating.

Testimony at the Safety Board's rail rapid transit safety hearing indicated that some transit authorities are reluctant to fully inform passengers of what to expect and what to do in the event of an emergency. Some obvious reasons for this are that if passengers know how to open the doors, they may precipitate a premature evacuation which could expose passengers to third rail electrical hazards or require a power shutdown that would make it impossible to move the train to a station, possibly immobilizing other passenger trains in a hazardous fire and smoke environment. However, major subway train accidents in Canada and the U.S. have resulted in some changes in passenger information. For example, it was not until after the BART Transbay Tube fire in 1979 that BART began providing detailed emergency information to passengers. Without adequate emergency

information, passengers are not likely to understand the frightening phenomenon of electrical fire, arcing, and undercar explosions on a subway train in a fire emergency, or to understand why they may be locked in the cars for an unspecified period of time while this is occurring.

NYCTA's bulletin providing for passenger information by public address system and immediate opening of car end doors if attempts to move the train fail, were in effect during five of the accidents investigated by the Safety Board; however, these measures did not prevent the precipitation of the evacuation by passengers panicking and breaking out windows in three of the five cases.

NYCTA's planned installation of motion detector circuitry to unlock car doors while a subway train is stopped may solve the problem of providing a means of emergency exit operable by passengers, while discouraging dangerous attempts by passengers to move between cars while a train is moving. At the same time, however, passenger emergency information is needed to give passengers an understanding of what to expect and what actions to take in the event of a fire or other emergency.

The exposure of additional passenger trains to a fire or smoke environment during an emergency, as revealed in at least one of the accidents investigated, can substantially increase the risk of passenger injuries and fatalities in such emergencies. Although NYCTA emergency procedures provide that passenger trains "should" not be operated in a tunnel when fire and smoke are present, there is no absolute prohibition on such operation. Another section of the emergency procedures appears to condone such operation by specifying that subway train air conditioning should be turned off momentarily when passing through smoke in a tunnel. The operation of subway trains with passengers aboard during BART's Transbay Tube fire was identified by the Safety Board, fire officials, the California Public Utilities Commission, and other organizations as unnecessarily exposing passengers to serious safety hazards. The occurrence of the same problem during NYCTA emergencies more than 2 years later, and the apparent inconsistency in NYCTA emergency procedures which appear to permit such hazardous operation, requires immediate attention. Procedures for emergencies involving fire and smoke in subway tunnels should explicitly prohibit any operation of a subway train carrying revenue passengers into an area where such an emergency exists.

Safety Oversight

The serious safety problems identified in this special investigation reflect the lack of systematic, independent oversight of NYCTA safety. NYCTA is financed by the Metropolitan Transportation Authority (MTA), the State of New York, and the Urban Mass Transportation Administration (UMTA). Yet no agency at any level of Government has undertaken the responsibility for seeing that the taxpayers' investment in this system provides for safe operations. What little safety oversight exists is exercised on an ad hoc basis in the wake of serious accidents. The Safety Board's periodic investigations of accidents and occasional studies on rail rapid transit safety issues, are not a substitute for continuing safety oversight of rail rapid transit systems. Moreover, the Safety Board is not a regulatory agency and has no authority to compel correction of safety problems. The Safety Board's recommendations, which are not binding, depend upon voluntary action by the recipients.

One of the issues considered at the Safety Board's public hearing was the question of whether or not Federal safety standards are needed for rail rapid transit systems. Labor unions representing rail rapid transit employees expressed strong support for Federal safety regulation, and local and National fire officials testified in support of safety standards or guidelines. UMTA and rail rapid transit management officials testified that Federal safety standards are not needed and would not be beneficial to safety. An NYCTA official testified, concerning safety standards for subway cars:

First, regarding the need for safety standards for rail rapid transit vehicles, we believe that they are not necessary. We think it important to realize that, since the inception of rail rapid transit service 75 years ago in New York City, the Transit Authority and its predecessors have prepared their own specifications for the purchase of cars. We have always recognized the need for safety awareness and have applied it to minimize the risk of fire or accident on our vehicles.

Industry groups, such as the Institute of Rapid Transit and its successor, the American Public Transit Association, have disseminated a continuous flow of information within the industry. Numerous publications and guidelines have been put forward. With this exchange of information, with review of guidelines, with tailoring vehicle specifications to our own individual properties, we have been able to, through an evolutionary process, achieve reliable and safe vehicles.

Efforts are now underway by APTA, in coordination with UMTA, to attempt to standardize those portions of the specifications which can be standardized. This is a worthwhile effort endorsed by the industry.

We do not believe that the establishment of another set of minimal [sic] safety standards by any Federal, State, or other governmental agency would aid us in improving safety in rail rapid transit.

The safety record for rail rapid transit is excellent. In our view, the record could not be improved by the establishment of a Federal safety standard for rail rapid transit cars.

The approach that has historically been taken has kept accountability for vehicle design at the local level. The management of each property has had to act with imagination and initiative in implementing those programs that are necessary to achieve an adequate level of safety.

What has happened over the years is that this local initiative, in trying to assure an adequate level of safety, has actually provided a superlative level of safety.

The serious safety problems revealed in this special investigation indicate that, in the absence of independent safety oversight, self-regulation by NYCTA has not proved effective. In its safety effectiveness evaluation report on rail rapid transit safety, the Safety Board observed that:

The increasing need for maintenance, with an implied reduction in safety inspection and surveillance of transit equipment and facilities may further impact the transit authorities' abilities to insure that minimum safety requirements are met.

The Board found that UMTA's safety oversight activities were extremely limited and inadequate, responding only to major safety problems identified through accidents, and concluded that: "Therefore, a series of minor, technical maintenance or procedural safety concerns may not be addressed in a systematic effort until after a major catastrophic accident occurs."

The inadequacies in NYCTA's car maintenance program identified more than 2 years ago have not been corrected despite the Safety Board's repeated warnings and recommendations. The gross maintenance deficiencies which led to a series of four derailments in 1978-79 led to a series of four motor control group fires 2 years later. No other agency at any level of Government followed up to see that previously identified safety problems were corrected. There was no safety oversight to see that NYCTA effectively resolved these problems before they led to another series of accidents.

At the Safety Board's rail rapid transit hearing, an official of the International Transport Workers Union of America testified that the complexity of transit technology has increased considerably, but there has not been a corresponding increase in the recurrent skill training of maintenance and operating personnel. Training and maintenance, according to the Union representative, are among the first items sacrificed when budgets have to be trimmed. To accomplish budget reductions in 1978, NYCTA reduced its maintenance force by more than 300 employees and extended the subway car inspection interval from 7,500 to 10,000 miles. The Union believes that safety has deteriorated, particularly on the older systems such as NYCTA and SEPTA, as economic troubles have worsened. He expressed amazement that:

...the Federal Government, which has gone to such lengths and such expense to help these rail systems by providing the greater part of the cost of this advanced-technology equipment, does such an inadequate job of making sure that it is maintained and operated properly.

The Union representative urged that one agency be made responsible for the safety and reliability of rail equipment on publicly-operated transit systems, and called for Federal safety standards in such areas as maintenance, training, security, passenger information, and emergency evacuation. Federal regulation, the Union representative testified, "would make these authorities responsible, in a legal sense, to someone," and would "enhance safety on a long-term and reliable basis, and that...is much more important than trying to deal with a catastrophe after it happens." Regulation, he testified, would provide checks and balances to assure that a transit system "does the things that it should be doing, regardless of political influence or the squeezing of budgets." Besides its power to attach safety conditions to Federal funding for rail rapid transit systems, UMTA's most direct safety oversight authority is its authority to conduct Section 107 investigations of unsafe conditions. However, the Department of Transportation has proposed that Section 107 be repealed "in an attempt to remove the Federal Government from an intrusive role in rail transit safety."

In its evaluation, the Safety Board found UMTA's Section 107 investigative authority unwieldy, primarily because it requires the existence of an unsafe condition as a prerequisite to investigation. This restriction operates, in effect, as a "Catch-22" because it is extremely difficult to make a determination that an unsafe condition exists without first investigating it. However, UMTA's Section 107 authority is so narrowly-defined that it does not permit UMTA to investigate a suspected safety problem to determine whether or not a condition is, in fact, unsafe. In its evaluation, the Safety Board noted that UMTA's investigation of unsafe conditions of NYCTA R-46 subway cars was the only time this authority had been used since Section 107 was enacted in 1974. UMTA also recognized the limitations of its Section 107 authority and had been seeking, before the Department proposed its repeal, the authority to establish investigative procedures that would clarify this function.

UMTA's investigation of the problems of NYCTA's R-46 subway cars was the only test of its Section 107 authority. In most respects it operated well, resulting in the identification of serious safety problems, the development of a corrective action plan, and implementation of the plan with UMTA's direct approval and oversight. However, this oversight by UMTA broke down in one critical area -- the current collector problems. UMTA approved NYCTA's planned corrective actions for the current collectors but failed to determine precisely what actions NYCTA was taking. If UMTA had monitored and evaluated NYCTA's corrective actions for the current collector as carefully as it had monitored actions to correct the other, more serious problems identified in the R-46 car, the four current collector fires might have been prevented.

With the exception of the current collector problem, UMTA's exercise of its Section 107 authority did operate as it was intended, to assure the correction of unsafe conditions which create a serious hazard of death or injury. In a July 22, 1981, letter to the Secretary of Transportation, the Safety Board expressed its views on the Department's proposal to repeal Section 107:

...we cannot agree that this Federal investigative authority has led to "an intrusive role in rail transit safety." In fact, as the Safety Board's evaluation noted, the Urban Mass Transportation Administration has exercised its authority under Section 107 on only one occasion, and that investigation identified serious safety problems in federally-funded R-46 transit vehicles. These results certainly benefited the local transit authority, the safety of its passengers, and the taxpayers' investment in rail rapid transit. In any case, it is our view that repeal of Section 107 would not relieve the Department of its responsibility to the public to insure that the rail rapid transit systems which it funds with taxpayers' dollars, and whose use it encourages, operate safely. It would only make it more difficult for the Department to fulfill its safety oversight responsibility.

One of the reasons given for UMTA's proposal to repeal Section 107 was that it overlaps or duplicates the authority of other Federal agencies such as the National Highway Traffic Safety Administration (NHTSA), the Federal Railroad Administration (FRA), and the Safety Board. In July 1981, the UMTA Administrator wrote to NHTSA, FRA, the Federal Highway Administration, the U.S. Coast Guard, the Occupational Safety and Health Administration, and the Safety Board to solicit information as to the legislative authority and willingness of those agencies to assume responsibility for investigating unsafe conditions in federally-funded mass transit systems. The Safety Board is aware that in some areas of mass transit, other Federal agencies have investigative authority which overlaps or duplicates UMTA's Section 107 Authority--for example, NHTSA has the authority to investigate and recall buses for safety defects, FRA has regulatory and investigative authority in light rail and commuter rail transit, and the U. S. Coast Guard has regulatory and investigative authority over ferryboat operations. In rail rapid transit, however, no other Federal agency has the authority to conduct extensive safety oversight. While the Safety Board investigates certain rail rapid transit accidents and performs occasional studies, its oversight capabilities are limited. The Safety Board does not have (nor does it seek) the authority for comprehensive and systematic safety oversight in rail rapid transit.

Investigative authority is an important and valuable safety oversight tool. While Section 107 provides that tool to UMTA, its authority is too narrow in that the existence of an unsafe condition creating a serious hazard of death or injury is a prerequisite to investigation. This tool would be far more effective if it were directed to investigation of

accidents and incidents or any condition which affects or could affect passenger safety for the purpose of determining whether or not an unsafe condition exists. This authority, coupled with the existing Section 107 authority to require submission of a corrective action plan and implementation of the approved plan under direct oversight, would provide one means of assuring the resolution of safety problems before they result in accidents. It is particularly important for UMTA to exercise an oversight role and maintain adequate investigative authority in this area because of its role in providing Federal financial assistance to rail rapid transit authorities. Safety must be a major area of consideration in providing Federal funding to rail rapid transit systems.

As a result of its accident investigations, the Safety Board identified the need for improved oversight of rail rapid transit safety as early as 1976. In its investigation of the head-on collision of two Greater Cleveland Regional Transit Authority (GCRTA) subway trains on July 8, 1977, ^{17/} the Safety Board again identified a safety problem which it previously identified 1 year earlier in its investigation of a rear-end collision of two GCRTA subway trains. ^{18/} The problem had not been corrected, although the Board had been assured after the first accident that its recommendation for corrective action had been implemented. Consequently, the Safety Board recommended on March 6, 1978, that the U.S. Department of Transportation:

Develop oversight capability to insure that the safety of rail rapid transit systems will be regulated and enforced by a responsible State or Federal agency. Within the Department of Transportation, accountability for the oversight should be assigned to the Administration that controls Federal grants to aid rail rapid transit. (Safety Recommendation R-78-10).

The following month, the Secretary of Transportation approved the delegation of complete responsibility for rail rapid transit safety within the Department to UMTA, and advised the Safety Board that a new rail rapid transit safety program plan was under development. However, the Safety Board's public hearing and evaluation of rail rapid transit safety in 1980-81 revealed that UMTA had adopted a largely passive Federal safety oversight posture which had not been effective.

As a result of its public hearing and safety effectiveness evaluation, the Safety Board concluded that there exists enormous potential for disaster in rail rapid transit systems, and recommended that the Secretary of Transportation:

Propose legislation to explicitly authorize the Secretary of Transportation to regulate the safety of rail rapid transit systems which receive Federal financial assistance. Such legislation should include the authority to establish Federal minimum safety standards, to enforce compliance, to conduct inspections, to conduct investigations of accidents and incidents, and such other general powers and duties as are necessary to provide for effective safety oversight. (Safety Recommendation R-81-1).

^{17/} Railroad Accident Report, "Head-on Collision of Two Greater Cleveland Regional Transit Authority Trains, Cleveland, Ohio, July 8, 1977" (NTSB-RAR-78-2).

^{18/} Railroad Accident Report, "Rear-End Collision of Two Greater Cleveland Regional Transit Authority Trains, Cleveland, Ohio, August 18, 1976" (NTSB-RAR-77-5).

Pending the enactment of legislation conferring direct regulatory authority, require the Urban Mass Transportation Administration to establish Federal guidelines for equipment and operations, to aggressively utilize existing grant programs and investigative authority to promote conformance with Federal guidelines, and to conduct a program of substantially increased safety oversight of Federal assisted rail rapid transit systems. (Safety Recommendation R-81-2).

In response to the first recommendation, the Secretary replied that there is no need for Federal regulatory authority, and that "rail transit safety is a local responsibility that is best handled by the State and local decisionmakers who are accountable for the safe, effective, and efficient operation of the rail transit systems." (See appendix C.) In response to the second recommendation, the Secretary replied that the UMTA safety program and activities would be evaluated for needed improvements.

In response to 18 safety recommendations made to UMTA, UMTA replied that it will take a variety of actions to improve its safety program and to address many of the specific concerns expressed by the Safety Board. (See appendix D.) These improvements are primarily in increased attention to fire safety problems and emergency training for both firefighters and rail rapid transit employees, and the development of safety guidelines and recommended practices to assist transit authorities in determining their own safety standards in certain areas.

The Safety Board is pleased that UMTA has indicated its plans to implement many of the Board's recommendations for needed safety improvements. However, some areas remain to be addressed and some of UMTA's planned improvements are contingent upon either the availability of funding, or decisions to be made by the end of 1981, when UMTA's safety program review is completed, as to whether the activities are necessary.

Improvements in UMTA's safety program are needed, and can have a very positive impact. However, UMTA still will not have the kind of capability for systematic safety oversight that is needed for systems like NYCTA. NYCTA faces more difficult challenges than most rail rapid transit systems because of its age, its size, and the fact that it requires a tremendous level of effort and resources just to maintain the system without expanding or adding improvements. Effective checks and balances are needed to assure that, as NYCTA addresses these challenges, existing safety problems are resolved and new problems affecting passenger safety are identified and resolved before they lead to accidents.

In a 1976 report, the Office of Technology Assessment of the United States Congress discussed the problem of safety regulation of rail rapid transit systems:

The opinion within the transit industry is that self-regulation is a workable solution. The excellent safety record of rail rapid transit is cited as proof that a self-regulating body can manage its affairs in a responsible manner, with the public interest as a foremost concern. The opponents of self-regulation, while not questioning the integrity and sense of responsibility of the local transit system officials, point out the inherent danger of vesting a single agency with the authority to conduct transit operations and oversee the results. Both sides of the argument have merit, and one of the basic issues in the area of public policy for rail rapid transit is to find a proper balance between external regulation

by a State or Federal agency (or some combination thereof) and responsible management by the local operating authority. 19/

The Safety Board has expressed its views on the need for Federal safety standards and systematic, comprehensive safety oversight of rail rapid transit systems. In view of the Department of Transportation's response, however, it appears that this type of activity will not be undertaken by the Federal Government at this time. Consequently, if the need for safety oversight of NYCTA is to be met, it must be met at the State or local level. Because the membership of the boards of directors of MTA and NYCTA are identical, however, MTA lacks sufficient independence from NYCTA to exercise effective safety oversight. In terms of both independence and authority, it appears that the State of New York is in the best position to undertake a safety oversight role, particularly in view of its role in funding NYCTA.

CONCLUSIONS

Findings

1. This special investigation of eight subway train fires revealed serious safety problems on the New York City Transit Authority which, if not corrected, could lead to the most tragic consequences.
2. The serious safety problems identified in this special investigation reflect the failure of responsible local, State, and Federal authorities to exercise effective oversight of NYCTA safety.
3. Pervasive and recurring inadequacies in NYCTA's car maintenance program led to the series of four motor control group fires.
4. Poor maintenance of subway cars has been a recurring problem on NYCTA; inadequacies in NYCTA's car maintenance program were identified by the National Transportation Safety Board more than 2 years ago as a result of its investigation of a series of four NYCTA subway train derailments.
5. The lack of adequate training and supervision in NYCTA's car maintenance program contributed to the occurrence of the four motor control group fires.
6. Motor control group "heavy burnups" — major motor control group fires — increased after NYCTA increased the interval between scheduled preventive maintenance of subway cars in October 1978 from 7,500 miles to 10,000 miles.
7. Although the Urban Mass Transportation Administration requires, as a condition of Federal funding, that new subway cars purchased by transit authorities meet certain specifications, NYCTA and other transit authorities are not subject to any UMTA requirements for maintenance of federally-financed subway cars after they are purchased.
8. The rupture of subway train main airbrake and motor control group air lines due to fire provided an unrestricted flow of air which created a bellows effect and contributed to the intensity of each of the motor control group fires and the severity of damage.

19/ Automatic Train Control in Rail Rapid Transit, May 1976, p. 167.

9. The problem of motor control group fires should have been identified earlier by NYCTA; however, although NYCTA's automated management information system records detailed data on subway car equipment failures, the system currently is not programmed to use these data to identify new or recurring equipment failures and bring them to the attention of NYCTA management before serious accidents occur.
10. The Urban Mass Transportation Administration, the State of New York, and the Metropolitan Transit Authority, all of which finance NYCTA, have not exercised safety oversight to assure that previously-identified inadequacies in NYCTA's car maintenance program were effectively resolved.
11. NYCTA's introduction of untried equipment into passenger service without prior testing led to the series of four current collector fires, and resulted, in effect, in a field test of the equipment on NYCTA passengers.
12. UMTA has not acted on the National Transportation Safety Board's recommendation that UMTA establish a safety certification process to identify to rail rapid transit authorities products or materials which meet minimum levels of safety.
13. Direct safety oversight by UMTA of the correction of unsafe conditions on NYCTA R-46 subway cars broke down in one critical area; if UMTA had overseen NYCTA corrective actions for the current collector as closely as it oversaw other corrective actions for the R-46 car, the four subway train accidents involving the current collector might have been prevented.
14. NYCTA motormen and conductors have not been trained to carry out their duties under NYCTA emergency procedures.
15. NYCTA's establishment of a firefighting training center for employees is a positive step; however, motormen and conductors, the first line of defense for passengers in the event of a subway train fire, have not been assigned top priority for this training.
16. The lack of any fire extinguishers on NYCTA subway trains limits NYCTA's ability to control a subway train fire in the critical early stages before flashover occurs.
17. Because NYCTA emergency procedures operate to discourage reporting a fire to the fire department before the problem is investigated, the forces that are best trained and equipped for firefighting and rescue operations may still be at the station, waiting for an alarm, when a major fire occurs in a New York subway.
18. The lack of adequate firefighting water supplies in most NYCTA subway tunnels makes it necessary for firefighters to extend hose lines from the street or a subway station, further delaying firefighting and rescue operations.
19. NYCTA does not provide adequate emergency information in subway cars on what to expect and what to do in the event of a fire or other emergency: how to escape from a burning train; the location of emergency alarm boxes, fire

extinguishers and ladders; how to avoid subway electrical hazards; and how to safely escape from subway tunnels when visibility is almost totally obscured by darkness and smoke.

20. NYCTA emergency procedures do not effectively prevent the dispatch or operation of passenger trains into an area where there is an emergency involving fire and smoke.

RECOMMENDATIONS

As a result of this special investigation, the National Transportation Safety Board made the following recommendations:

--to the New York City Transit Authority:

Establish a systemwide program of initial and recurrent training for car repairmen, car inspectors, maintenance foremen, and quality assurance personnel. (Class II, Priority Action) (R-81-103)

Reduce the current 10,000-mile interval between major subway car inspections to provide for more frequent scheduled car maintenance. (Class II, Priority Action) (R-81-104)

Increase maintenance surveillance and enhance quality assurance of subway car inspections. (Class II, Priority Action) (R-81-105)

In conducting "hands on" training of employees for responding to emergencies, assign top priority to the training of motormen and conductors. (Class I, Urgent Action) (R-81-106)

Provide training to motormen and conductors to enable them to evaluate emergencies, communicate vital information immediately to appropriate authorities, and ascertain when conditions require the immediate evacuation of passengers. (Class II, Priority Action) (R-81-107)

Provide at conspicuous places in all NYCTA subway cars, instructions for passengers on what to do in the event of an emergency, including how to escape from burning cars, the location of emergency telephones, ladders and fire extinguishers, and how to exit safely from a tunnel under fire and/or smoke conditions. (Class II, Priority Action) (R-81-108)

Provide at least two fire extinguishers, one at each motorman and conductor position, in all subway trains. (Class I, Urgent Action) (R-81-109)

Prohibit the introduction of untried or untested equipment into passenger service. (Class I, Urgent Action) (R-81-110)

Clarify to Command Center personnel the importance of notifying the fire department immediately when a fire is detected or suspected. (Class I, Urgent Action) (R-81-111)

Revise NYCTA emergency procedures to prevent the dispatch or operation of a train with revenue passengers aboard into an area where there is an emergency involving fire and smoke. (Class I, Urgent Action) (R-81-112)

Relocate the main airbrake line of subway cars away from the motor control group to reduce the possibility of rupture in the event of a motor control group fire. (Class II, Priority Action) (R-81-113)

In subway cars having an air-activated motor control group cam, modify the air lines to provide a means of preventing the unrestricted flow of air in the event they are ruptured. (Class II, Priority Action) (R-81-114)

Revise the NYCTA automated management information system to provide sufficient detailed information to permit analysis of the incidence and causes of failures or malfunctions of equipment which may affect the safety of passengers. (Class II, Priority Action) (R-81-115)

--to the Governor of the State of New York:

Initiate legislative and/or executive action to authorize a new or existing independent agency to oversee and regulate the safety of the New York City Transit Authority. (Class II, Priority Action) (R-81-116)

--to the U.S. Secretary of Transportation:

Propose legislation to amend Section 107 of the National Mass Transportation Assistance Act of 1974 to substitute, for the Secretary's authority to investigate unsafe conditions in federally-funded mass transit systems, the authority to investigate any mass transit accident or incident in such systems, or any condition which affects or could affect the safety of passengers. (Class II, Priority Action) (R-81-117)

-- to the Urban Mass Transportation Administration:

Establish procedures to monitor, evaluate, and assure that approved plans to correct unsafe conditions are carried out by transit authorities and that no changes in the plans are approved or made without adequate evaluation. (Class II, Priority Action) (R-81-118)

In addition, the National Transportation Safety Board reiterates the following recommendation, which originally was issued on February 11, 1981 to the Urban Mass Transportation Administration:

Establish a process, based upon testing and evaluation in accordance with such criteria as the Administration shall establish, for the certification or identification of specific products and materials used in the construction of rail rapid transit cars as meeting minimum safety standards or guidelines, and provide this information to rail rapid transit authorities on a regular basis. (Class II, Priority Action) (R-81-11)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ PATRICIA A. GOLDMAN
Member

/s/ G. H. PATRICK BURSLEY
Member

FRANCIS H. McADAMS, Member, did not participate.

September 22, 1981

APPENDIXES

APPENDIX A

FIELD INVESTIGATIONS OF MOTOR CONTROL GROUP
AND CURRENT COLLECTOR FIRES

<u>Accident Location and Date</u>	<u>NTSB File Number</u>
South of 86th Street Station, Manhattan, New York, New York City Transit Authority, June 25, 1980	NYC-80-F-R065
South of Queens Plaza Station, Queens, New York, New York City Transit Authority, December 10, 1980	NYC-81-F-R019
Bronx, New York, New York City Transit Authority, December 11, 1980	NYC-81-F-R020
Roosevelt Avenue Station, Queens, New York, New York City Transit Authority, April 21, 1981	NYC-81-F-R038

APPENDIX B

IRT DIVISION CARS
MOTOR CONTROL GROUP HEAVY BURN UPS 1979

<u>Date Shopped</u>	<u>Car Number</u>	<u>Car Type</u>	<u>Motor Control Group Type*</u>
JAN 22 79	7860	R-28	WH
FEB 22 79	6614	R-17	GE
FEB 23 79	7318	R-22	WH
MAR 9 79	7781	R-26	GE
MAR 13 79	8576	R-29	WH
APR 2 79	7786	R-26	GE
MAY 4 79	7920	R-28	GE
MAY 14 79	7824	R-26	WH
MAY 31 79	7782	R-26	GE
JUN 5 79	8619	R-29	WH
JUN 13 79	7309	R-22	WH
JUN 18 79	7375	R-22	WH
JUL 23 79	8611	R-29	WH
JUL 24 79	7906	R-28	WH
JUL 30 79	7520	R-22	WH
AUG 8 79	8683	R-29	WH
AUG 13 79	7222	R-21	WH
AUG 13 79	8665	R-29	WH
SEP 4 79	7564	R-22	GE
SEP 6 79	7142	R-21	GE
SEP 10 79	7515	R-22	WH
SEP 11 79	7284	R-21	WH
OCT 3 79	8621	R-29	WH
OCT 25 79	7633	R-22	GE
OCT 29 79	6627	R-17	GE
OCT 29 79	7905	R-28	WH
OCT 31 79	5903	R-14	WH
OCT 31 79	7480	R-22	WH
NOV 9 79	7425	R-22	WH
DEC 31 70	5743	R-12	WH

Subtotals

21 WH
9 GE

Total 30

*WH = Westinghouse
GE = General Electric

APPENDIX B

IRT DIVISION CARS
MOTOR CONTROL GROUP HEAVY BURN UPS 1980

<u>Date Shopped</u>	<u>Car Number</u>	<u>Car Type</u>	<u>Motor Control Group Type*</u>
JAN 2 80	5950	R-14	WH
JAN 21 80	5751	R-12	WH
MAR 31 80	5720	R-12	WH
MAY 8 80	8577	R-29	WH
MAY 9 80	6834	R-17	WH
MAY 12 80	8877	R-33	GE
MAY 23 80	9199	R-33	WH
MAY 28 80	6872	R-17	WH
JUN 13 80	5913	R-14	WH
JUN 13 79	5918	R-14	WH
JUN 26 80	8815	R-33	GE
JUL 14 80	6664	R-17	GE
JUL 14 80	9077	R-33	WH
JUL 21 80	9211	R-33	WH
JUL 28 80	7926	R-28	GE
AUG 18 80	9209	R-33	WH
AUG 18 80	9232	R-33	WH
AUG 29 80	9254	R-33	WH
SEP 4 80	9528	R-36	WH
SEP 10 80	9522	R-36	WH
OCT 7 80	8650	R-29	WH
OCT 20 80	7310	R-22	WH
OCT 23 80	8641	R-29	WH
NOV 3 80	9514	R-36	WH
NOV 4 80	9540	R-36	WH
NOV 17 80	9235	R-33	WH
NOV 19 80	7946	R-28	GE
NOV 20 80	8619	R-29	WH
NOV 26 80	7886	R-28	WH
DEC 2 80	5906	R-14	WH
DEC 3 80	7869	R-28	WH
DEC 5 80	7750	R-26	GE
DEC 5 80	9089	R-33	WH
DEC 8 80	8595	R-29	WH
DEC 15 80	9300	R-33	WH
DEC 22 80	6210	R-15	WH

Subtotals

30 WH

6 GE

Total 36

*WH = Westinghause
GE = General Electric

APPENDIX C

THE SECRETARY OF TRANSPORTATION'S REPLIES TO
SAFETY RECOMMENDATIONS R-81-1 and R-81-2



THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

APR 22 1981

Honorable James B. King
Chairman
National Transportation
Safety Board
Washington, D.C. 20594

Dear Mr. King:

Thank you for your recent correspondence which transmitted the Board's Safety Recommendations R-81-1 and R-81-2 and a copy of the Board's related report, "Safety Effectiveness Evaluation of Rail Rapid Transit Safety," dated January 22, 1981. This letter responds to your two recommendations.

Under Recommendation R-81-1, the Board recommends that the Department propose legislation to explicitly authorize it to regulate the safety of rail rapid transit systems which receive Federal financial assistance, and outlines the scope of what should be included in such legislation.

With respect to Recommendation R-81-1, I believe there is no necessity to seek legislation to explicitly authorize the regulation of the safety of rail transit systems which receive Federal financial assistance. In fact the Department is seeking to repeal Section 107 of the National Mass Transportation Assistance Act of 1974, in an attempt to remove the Federal government from an intrusive role in rail transit safety. We believe rail transit safety is a local responsibility that is best handled by the State and local decision-makers who are accountable for the safe, effective, and efficient operation of the rail transit systems.

Under Recommendation R-81-2, the Board recommends that the Department require the Urban Mass Transportation Administration (UMTA) to carry out a number of identified actions pending enactment of the legislation described under Recommendation R-81-1.

With respect to Recommendation R-81-2, the UMTA safety program and activities will be evaluated for needed improvements over the next several months. This evaluation will focus on how UMTA can improve its role as a technical and financial assistance agency in the area of transit safety. The guidelines identified by the Board in this recommendation and in the recommendations made to UMTA (R-81-3 through R-81-20) will be fully considered in the evaluation. UMTA's letter of February 26, 1981, advised you of actions UMTA plans to take on your recommendations.

Sincerely,

A handwritten signature in cursive script, appearing to read "D. W. Lewis".



THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

AUG 24 1981

The Honorable James B. King
Chairman
National Transportation
Safety Board
Washington, D.C. 20594

Dear Mr. King:

This is in reply to your recent letter regarding my response to your Safety Recommendations R-81-1 and R-81-2, which were issued by the Board as a result of its "Safety Effectiveness Evaluation of Rail Rapid Transit Safety." In that letter the Board requested that Recommendation R-81-1, which recommends that the Department propose legislation to explicitly authorize it to regulate the safety of rail rapid transit systems which receive Federal financial assistance, be given further consideration.

As I stated in my letter of April 22, 1981, I do not believe that such legislation is necessary. While some recent accidents and incidents have indicated that there are a number of safety problems in rail rapid transit, I do not believe that making the Urban Mass Transportation Administration (UMTA) a regulatory agency and promulgating safety regulations and standards is the most effective way to resolve them. The promulgation of national safety standards for rail rapid transit would be extremely difficult due to the various site-specific design and operational constraints of each system. The use of available resources to ensure compliance with the standards, at both the Federal and local levels, would result in decreased resource availability in other preventive safety activities such as hazard identification, analysis, and resolution, safety research, and safety training.

With respect to the Board's comments on the currently fragmented safety efforts in rail rapid transit, the Department agrees that the research and study of generic rail transit safety problems should be consolidated at the national level. UMTA is currently doing research on two of the most significant generic safety problems in rail rapid transit, emergency

preparedness, and fire safety. UMTA intends to publish guidelines for transit properties to use in both of these safety problem areas. These guidelines would not be mandatory, but would be a summary of best recommended practices.

Relative to your comments concerning our proposed repeal of Section 107, UMTA has, as you know, recently queried several other Federal agencies (your agency, Federal Railroad Administration, Federal Highway Administration, National Highway Traffic Safety Administration, United States Coast Guard, and Occupational Safety and Health) concerning their legislative authority and willingness to accept the Section 107 responsibilities. The responses, when received, will help determine if a reevaluation of our proposed repeal of Section 107 is appropriate.

You have, by now, received UMTA's responses to recommendations R-81-3 through R-81-20, by their letter of July 17, 1981. Since the recommendations and the responses cover a wide range of specific efforts, the sum of that letter essentially provides our response to recommendation R-81-2.

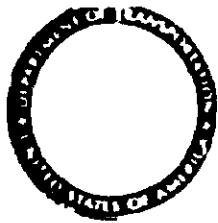
I appreciate the effort that you and your staff have expended in developing and providing significant recommendations for improving overall rail rapid transit system safety.

Sincerely,

A handwritten signature in dark ink, appearing to read "Drew Lewis". The signature is fluid and cursive, with the first name "Drew" being more prominent and the last name "Lewis" following in a similar style.

APPENDIX D

THE URBAN MASS TRANSPORTATION ADMINISTRATION'S REPLIES TO
SAFETY RECOMMENDATIONS R-81-3 THROUGH R-81-20



DEPARTMENT OF TRANSPORTATION
URBAN MASS TRANSPORTATION ADMINISTRATION
WASHINGTON, D.C. 20590

ADMINISTRATOR

JUL 17 1981

The Honorable James B. King
Chairman
National Transportation
Safety Board
Washington, D.C. 20594

Dear Mr. King:

The Urban Mass Transportation Administration's (UMTA) response to the Board's Safety Recommendations R-81-3 through R-81-20, is enclosed. These recommendations are identified in the Board's Report, NTSB-SEE-81-1, Safety Effectiveness Evaluation of Rail Rapid Transit Safety, dated January 22, 1981. The report is based on the public hearing the Board conducted on July 28 and 29, 1980 in Washington, D.C.

Please accept my appreciation for the time and effort expended by the Board and its staff in developing and providing significant recommendations for improving the fire and life safety aspects of rail rapid transit, UMTA's related role, and our overall transit safety program.

You will find that our overall response is consistent with the April 22, 1981 response by Secretary Lewis to the Board's Recommendation R-81-1 regarding legislation to explicitly authorize the Department to regulate the safety of rail rapid transit systems which receive Federal financial assistance. I have concurred in the Secretary's response. I believe that the UMTA transit safety program to assist the maintenance of safety accountability by rail rapid transit authorities fundamentally has been sound. It may better optimize the operational safety of individual transit systems than a regulatory program. We believe this has been demonstrated.

2

I am conducting an evaluation of the total UMTA organization and related functional and funding programs, which may result in significant organizational changes and redirection of programs and related funding. This activity should be completed by the end of this calendar year. Accordingly, we will revise pertinent responses to individual recommendations where such responses may be affected by our evaluation activity.

Again, thank you for the insight the Board has provided for improving our safety program and activities. I trust you will find that UMTA has been responsive to your needs.

Regards.

Sincerely,



Arthur C. Teele, Jr.

Enclosure

RESPONSE TO
NATIONAL TRANSPORTATION SAFETY BOARD
SAFETY RECOMMENDATIONS
R-81-3 THROUGH R-81-20

BY THE
URBAN MASS TRANSPORTATION ADMINISTRATION
OF THE
DEPARTMENT OF TRANSPORTATION

June 1981

RESPONSE TO NTSB SAFETY RECOMMENDATIONS TO UMTA

Recommendation R-81-3: In cooperation with rail rapid transit authorities and local fire officials, immediately survey the facilities, communication systems, fire safety and other emergency equipment, and emergency plans of existing rail rapid transit systems to determine their capability for evacuation of passengers under various operational and passenger load conditions.

Response

As was brought out in the testimony of the UMTA Deputy Administrator at the NTSB public hearing in July 1980, UMTA had acted to implement an Emergency Preparedness project. Guidelines will be produced under this project for the evaluation and needed improvement in the capability of individual systems to evacuate passengers under various load conditions. The project is being carried out with the cooperation of the American Public Transit Association, (APTA), including personnel from individual rail rapid transit systems, and the United States Fire Administration (USFA). The USFA also is completing a fire/life safety survey of various rail transit properties. The results of this survey will be used as source material for the development of emergency preparedness guidelines and training material.

Recommendation R-81-4: Establish procedures to consult organizations, such as the United States Fire Administration, the International Association of Fire Chiefs, the International Association of Fire Fighters, the National Fire Protection Association, and employee unions, as appropriate, in addition to the American Public Transit Association and individual transit properties, in developing Federal guidelines for car and tunnel designs, safety equipment requirements, training programs (including emergency response) and other appropriate safety areas.

Response

The USFA will be maintaining liaison for UMTA with various fire associations to ensure that their interests and needs are brought forth.

Due to the diversity and number of unions (and their locals) that represent the employees of various rail transit properties, it would be impractical for UMTA to consult with and acquire assistance from each of these organizations. A more effective method of involving the rail transit employee unions in appropriate safety areas would be for the properties to work directly with their specific union local officials. UMTA will actively encourage this type of activity, and assist its application, as part of its system safety review activities. In addition, UMTA will exchange information with union officials on pertinent safety issues through correspondence and meetings.

Recommendation R-81-5: Make appropriate organizational changes to provide for more direct consideration of safety issues in the formulation of the Administration's rail rapid transit policies and priorities.

Response

UMTA currently is carrying out a reorganization activity which is expected to be completed by the end of Calendar Year 1981. The Board's recommendation for organizational changes will be considered under this activity.

Recommendation R-81-6: Establish, on a priority basis, Federal guidelines for the elimination or minimization of combustible and toxic gas and smoke-generating materials in existing rail rapid transit cars. Wherever possible, adherence to these guidelines should be made mandatory as a condition of Federal financial assistance.

Response

Over the years, guidelines for flammability and smoke emission specifications have been developed and periodically improved by the Transportation Systems Center (TSC) and disseminated by UMTA. These guidelines are being widely used in the development of specifications for new rail transit vehicle procurements. (AMTRAK also has used them in rail vehicle procurements.) They also have been used as guidance in rail transit vehicle retrofit projects.

We will be issuing no mandatory requirements for application of these guidelines. In the near future, however, we will be soliciting transit industry, fire officials and public comment on the latest version of the guidelines via the Federal Register. They then will be disseminated as "recommended practices".

Recommendation R-81-7: In cooperation with rail rapid transit authorities and local fire officials, assess the need for modification or retrofit of existing rail rapid transit cars to reduce the potential for the exposure of combustible or toxic materials to fire.

Response

It is appropriate that individual rail rapid transit authorities conduct activities to assess the need for modification or retrofit of cars, in cooperation with local fire officials. We will encourage and support such activities as our joint emergency preparedness and fire/life safety activities are carried out.

Recommendation R-81-8:

Include in Federal financial assistance to rail rapid transit systems an ability to provide funding for acquisition of emergency equipment and for periodic inspection, maintenance, and testing of such equipment after it is installed.

Response

Capital Assistance funds are available to transit properties to assist procurement of new equipment. Operational subsidy funds are also currently available to assist the inspection, maintenance and testing of equipment, although funding of these activities may become state, regional or local responsibilities in the future.

Recommendation R-81-9: Develop and publish for public comment a comprehensive, 5-year safety program plan for increased safety oversight of new rail rapid transit systems as they are developed and for improving the safety of existing systems.

Response

An UMTA rail transit safety program plan will be developed and published for public comment, if it is needed, after our reorganization activity discussed under response to Recommendation R-81-5 is completed. If such a plan is published, we would intend it to be applicable for at least 5 years.

Recommendation R-81-10: Develop and publish for public comment a comprehensive, 5-year plan for rail rapid transit safety research and development.

Response

Refer to response under Recommendation R-81-9. An R&D plan was published in September, 1980 and disseminated to the transit industry. We would revise this plan for at least 5-year applicability and publish it for public comment, if it is still needed after our reorganization activity is completed.

Recommendation R-81-11: Establish a process, based upon testing and evaluation in accordance with such criteria as the Administration shall establish, for the certification or identification of specific products and materials used in the construction of rail rapid transit cars as meeting minimum safety standards or guidelines, and provide this information to rail rapid transit authorities on a regular basis.

Response

We do not intend to establish either mandatory or minimum safety standards for specific products or materials used in the construction of rail rapid transit cars. Nor do we intend to establish either mandatory or minimum criteria for the certification or identification of such products.

We intend to continue our technical and funding assistance and cooperative efforts to achieve the highest practical levels, or optimum of safety, on the part of individual rail transit properties. We will continue to provide technical assistance in the development of recommended programs, processes and practices (guidelines) by which these properties may achieve the optimum levels of safety, and self-certify the safety of their systems and system elements.

Recommendation R-81-12: Develop and publish for public comment a formal plan for the review, evaluation, and certification of rail rapid transit system safety plans.

Response

Refer to response under Recommendation R-81-9. Guidelines for the review and evaluation of rail rapid transit system safety plans and programs are currently under development. These guidelines will be published for public comment as part of and concurrent with our rail transit safety program plan. Content guidelines for system safety program plans are also being developed.

Recommendation R-81-13: Establish a fire safety research and testing program to assess the combustibility and toxic gas and smoke generation of materials used in the construction of rail rapid transit cars and to evaluate the fire safety of rail rapid transit cars through full-scale testing.

Response

As brought out by the UMTA Deputy Administrator in the Board's hearing in July, 1980, such a program has been implemented and is continuing. The program involves:

- identification of methods to eliminate or control the fire threat;
- development of fire countermeasures; and
- maintenance of materials information bank.

Detailed information on future activities will be provided in our safety R&D program plan. (Reference response to Recommendations R-81-9 and R-81-10.)

Recommendation R-81-14: Offer to assist and cooperate with the United States Fire Administration in its development of a national training curriculum for fire service personnel involved in the administration of fire protection on rail rapid transit systems.

Response

UMTA has implemented mutual assistance and cooperative activities with the U.S. Fire Administration (USFA) on training and related fire/life safety matters. We currently are processing an UMTA funded inter-agency agreement with the Federal Emergency Management Agency (FEMA) to strengthen these activities. FEMA/USFA initially will provide assistance to the UMTA safety program by:

- conducting fire/life safety workshops to determine transit and fire service training requirements;
- identifying site specific fire/life safety training and education needs;
- participating in UMTA safety reviews;
- providing technical assistance in the development and review of an emergency preparedness guideline manual for rail transit; and
- providing general technical assistance as needed, including acting as liaison between UMTA and fire service organizations.

Recommendation R-81-15: Develop Federal guidelines for training programs for rail rapid transit employees, to include actual performance, under simulated conditions, of the duties they may be required to perform in the event of a fire or other emergency.

Response

We plan to develop the guidelines under the UMTA inter-agency agreement with FEMA/USFA, as stated above. The guidelines will be used in transit training/education courses that FEMA/USFA provide through the Federal Emergency Training Center. They also will be disseminated to rail transit properties for local training.

Recommendation R-81-16: Conduct research to determine the most effective means of informing rail rapid transit passengers of the actions to be taken in the event of an emergency, the location of emergency equipment, and the means of operating vehicle exit doors, and promulgate Federal guidelines.

Response

Rather than conducting a specific research project, we intend to identify the effective means the Board outlined above, in the emergency preparedness guidelines manual and related training/education programs. The USFA survey report (reference response to Recommendation R-81-3) will be used as source material in identifying the means.

Recommendation R-81-17: Study and evaluate the need for fire suppression systems on new rail rapid transit vehicles and conduct research and development, and develop and promulgate Federal guidelines if so indicated.

Response

UMTA plans to implement a study project in FY-82 to evaluate the need, availability, reliability, maintainability, and benefit of installing fire suppression systems on new rail rapid transit vehicles, if funds are available.

Recommendation R-81-18: Require rail rapid transit authorities to have a formal, continuing process for including local fire and emergency medical service officials in reviews of fire and life safety considerations during system planning, design, construction, and operation.

Response

All new rail rapid transit authorities develop working relationships and related agreements with fire, police, and with medical services during the development of their systems. Fire and life safety issues are addressed. Operational rail rapid transit authorities maintain similar relationships and related agreements to varying degrees.

These activities have been carried out without the imposition of UMTA requirements. We intend that they will continue to be carried out in the same manner. We also expect that, where constructive improvements are identified through the USFA survey, the emergency preparedness project, and education and training activities, these improvements will be introduced.

Recommendation R-81-19: Include local fire and emergency response services in onsite reviews performed by the Administration of new and existing rail rapid transit systems.

Response

In recent reviews of new systems at Dade County (Miami) in January 1981, and at Baltimore in March, 1981 both the USFA and local fire/emergency response personnel participated. We will acquire similar participation in future new system reviews, and in future existing system reviews.

Recommendation R-81-20: Until such time as comprehensive, formal safety standards have been established for rail rapid transit, publish an annual report assessing the degree of conformance or nonconformance of rail rapid transit systems with each Federal safety guideline established by the Administration.

Response

UMTA does not plan to establish comprehensive formal safety standards for rail rapid transit. Standards would preempt local safety accountability, and would be intrusive in local decision making. UMTA does plan to publish guidelines and disseminate them as recommended practices. We currently publish annual reports to the public which provide statistical information on accidents, incidents and casualties on rail rapid transit systems. In addition, all operational rail rapid transit authorities have or will have documented system safety program plans, and related programs and activities. We periodically review an authority's system safety program for conformance with its plan, and provide recommendations for improvement via a report to the General Manager. It may be beneficial to expand the content of the current annual report to include information on all our program activities. We will consider doing this.

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